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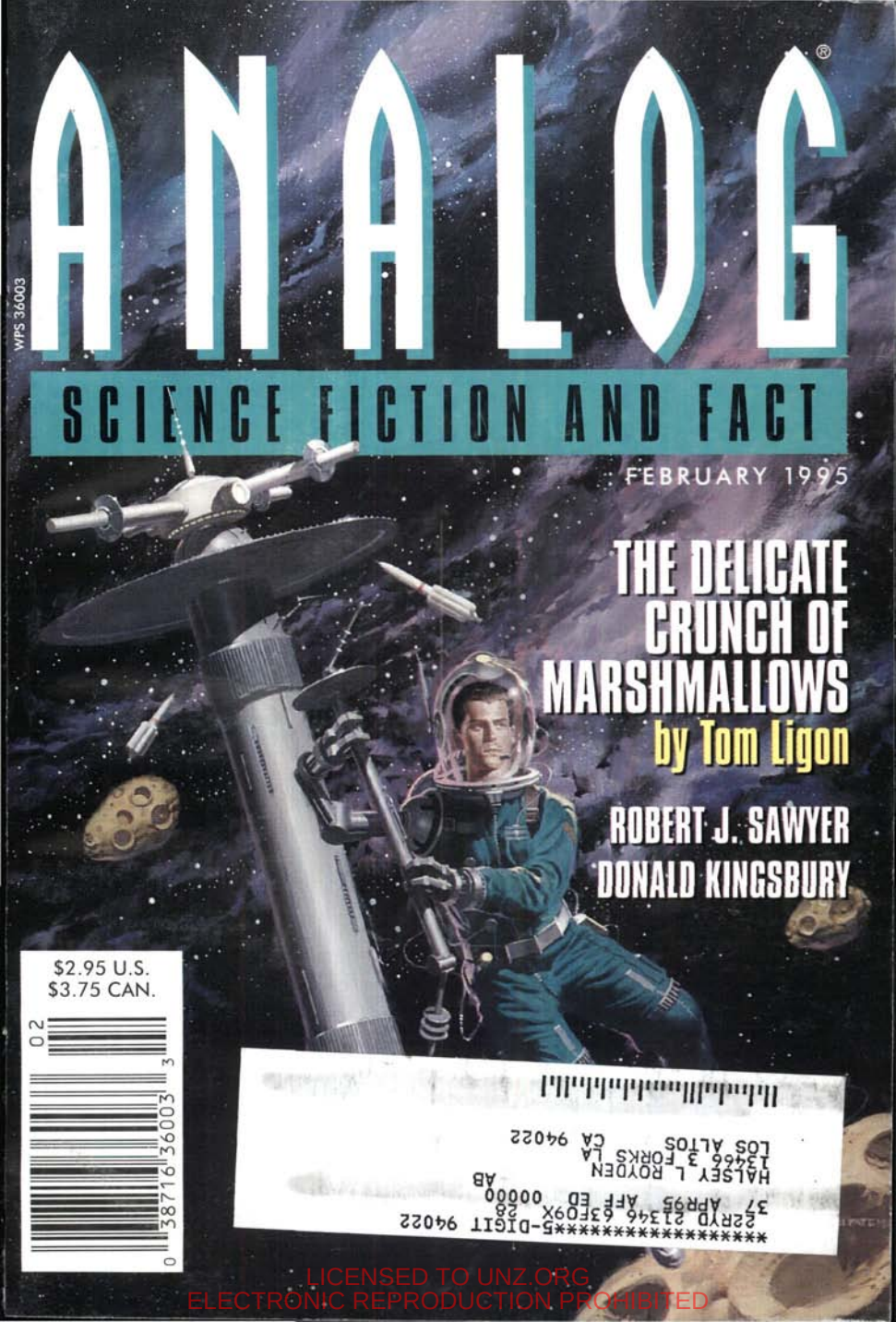

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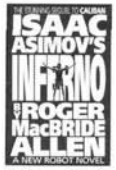

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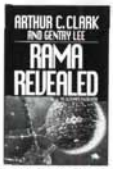

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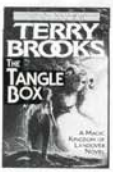

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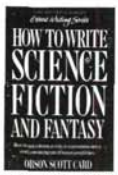

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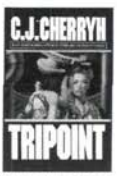

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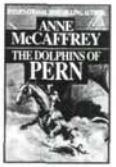

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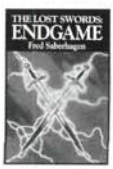

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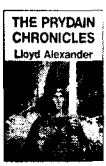

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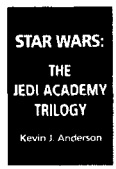

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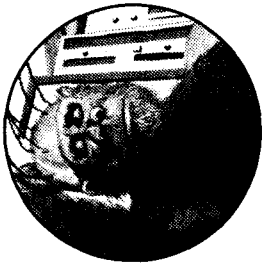

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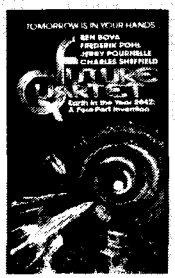

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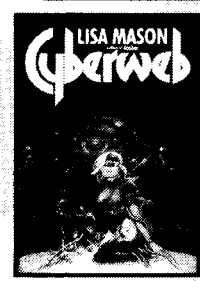

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EDITORIAL Stanley Schmidt

EXCUSES AND EVOLUTION

"I was too drunk to know what I was doing."

"It was her fault; the way she was dressed, she was asking for it."

"After he abused me for years, I felt I had to do it in self-defense."

"I was blinded by jealous rage. I plead not guilty by reason of temporary insanity."

"He's only a kid. We can't treat him as if he really understood what he was doing when he killed the old lady."

"You can't blame *them* if they're sexually irresponsible. They're only kids, and they're constantly bombarded by messages that it's OK."

"*I* didn't do it. God was acting through me."

"We can't treat him as if it were all his fault. He came from a dysfunctional family in a bad neighborhood. *Society* killed the victim . . . ."

"But he's very popular and he did so many *good* things. How can we give him the punishment this one slip seems to warrant?"

"There was a typo on the search warrant, so we'll have to throw out all the evidence even though it clearly proves her guilty. Case dismissed!"

Sound familiar? You've heard them all many times, along with so many others that it's really rare to hear a new one (like the man who claimed he shot his wife because he mistook her for a raccoon). People have probably always tried to pass the responsibility for their own stupidities and evils off onto someone else. What's new and disturbing is that so many people, including judges and juries, now take such excuses seriously. They can find some excuse for virtually any action, and thereby avoid making anyone accept full responsibility for his or her own behavior. And obviously, if one is not fully responsible for his own misdeeds, then he shouldn't have to pay the full price. Right?

Such, at least, seems to be the currently popular belief. The short-term consequences should be fairly obvi-

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ous. I have yet to hear a more convincing explanation for the galloping prevalence of various sorts of crime in our present society. Cases are so often thrown out of court, and sentences so often reduced to triviality, or cut short after a small fraction has been served, that hardly anybody takes the law or the threat of punishment very seriously any more.

We've been hearing a lot of calls lately for restoring the death penalty in more places that don't have it, or emulating Singapore's extreme penalties for minor offenses. But I don't believe the problem is the lack of a death penalty or caning. The problem is the lack of any *consistent* penalty—for anything. There are plenty of penalties already on the books that simply don't happen much in the real world. If they did, I suspect that fact would have far more of a deterrent effect than having still more and harsher penalties that usually exist only on paper.

It's not just a matter of law, of course. It's also a matter of attitude, a way of looking at the world and one's obligations to it that needs to be instilled primarily in the home. Ideally, it should be reinforced by forces outside the home—but blaming those for the widespread deterioration in personal standards for behavior is merely another example. Yes, it would be nice if parents trying to raise kids whose attitudes are compatible with a sane and reasonably safe society got support for their efforts from other segments of that society. But it's *their* responsibility, whether anybody else helps or not, to do everything in their power to instill those attitudes and the strength of character to live by them. And foremost among them is this belief: "I, and I alone, am responsible for my actions."

Sure, no act exists in isolation; everything any of us does is influenced by everything that's ever happened to us. But that does not mean that everything can be written off as excusable. Too many of us seem to have lost the valuable concept that some actions are just plain unacceptable and should not be tolerated, whatever the reason.

The first excuse on my list has fallen into disfavor; drunkenness is currently under popular attack and few people accept it as an excuse for anything. All of the others, however, are still frequently heard and frequently accepted as excuses; no

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doubt at least a few of them will instantly recall at least one highly publicized recent case to your mind. But why should any of them be treated as excuses?

"The way she was dressed . . ." may suggest prudent advice for somebody who wants to minimize her chances of being a victim in a highly imperfect world, but it has absolutely no relevance at the trial. A society that hopes to remain viable must insist that its citizens consider rape or murder something that they don't do under *any* circumstances. Any person who can't resist the impulse is a hazard to everyone and cannot be tolerated.

"Self-defense" is a valid excuse under certain very limited circumstances. If I break into your house and try to shoot you, it makes excellent sense for you to shoot me first. But "self-defense" for a violent act committed in response to prolonged lower-level abuse over a long period of voluntarily living with someone? Far-fetched, and all too easy to extend to a whole flood of equally far-fetched defenses. No, I am *not* condoning the abuse. I am merely saying that premeditated acute violence is not an acceptable response to it. *Both* the abuse and the violent response should be treated as behavior that will not be tolerated. (There is, of course, an important corollary. If people with long-term grievances are to accept this idea, they must know they can count on enough real support from the law so they won't feel obliged to take it into their own hands.)

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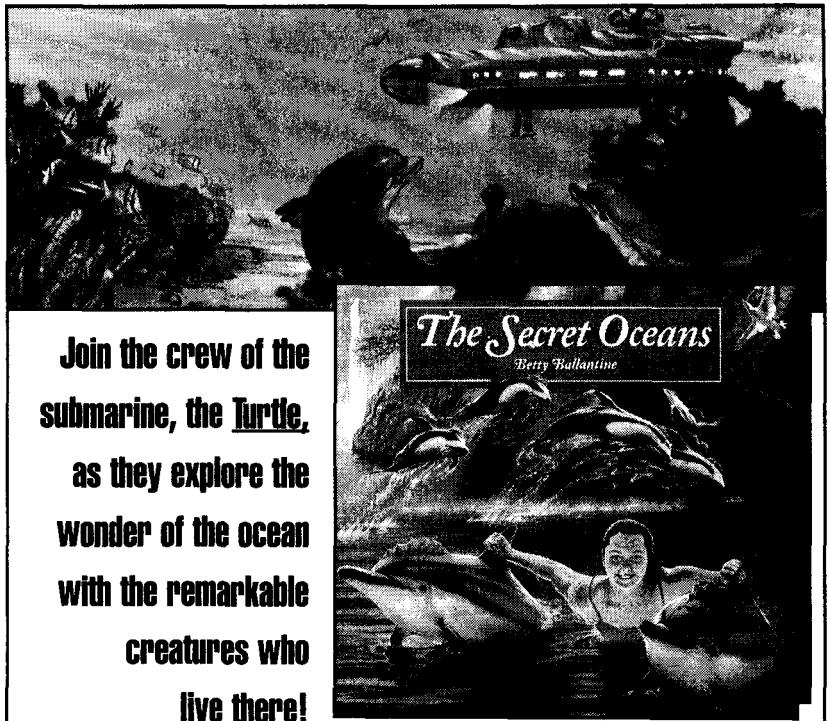

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And so on down the list. Being a juvenile or beset by jealous or racial rage does not excuse violence. The victim is just as dead whether killed by a very young person who can't control his emotions or by a coldly calculating 40-year-old. Inability to exercise self-control, like drunkenness, is an additional offense, not an excuse. We must insist that people learn to control their emotions at least well enough to keep them from leading to violence, and we must insist that they learn that quite early.

And if they can't?

That question leads us to the *long-term* effects of constantly making excuses for people and protecting them from the consequences of their own actions. Like most long-term effects, they are not ones people like to think about.

The key issue is evolution, both of human societies and of the human animal—a concept our society in particular has tried very hard to sweep under the rug. A society that insists on making excuses for criminals and incompetents, and turns them loose to repeat their offenses and make more like themselves, is asking for trouble on two levels. The society will consist increasingly of such people, and so will the gene pool on which future societies must depend.

People, like any other organisms, are products of *both* genetics and environment. Probably all of our characteristics are shaped to varying extents by both kinds of influences. Most people consider that self-evident when talking about breeding other species, but can't grasp that it applies to *them*.

Nevertheless, it does. People got where they are by trying lots of genetic combinations and exposing them to a variety of environments. Some people were more capable than others of dealing with environmental stresses, and lived long and/or passed new combinations of their genes on to new generations. Others didn't do so well. In the "bad old days," environmental pressures tended to hold down the numbers of people (or any species) physically or mentally incapable of dealing with them. Those who couldn't cope often didn't live long enough to reproduce. Those with a high susceptibilty to disease, or not enough wits to catch or grow food and prepare it safely, didn't make it. For the individuals involved, it was a harsh system (and still is, for most nonhumans). But for the species, it had the advantage of ensuring a high percentage of highly fit individuals, with a good chance of producing offspring with similar characteristics.

Humans, to a far greater extent than any other species on this planet, have managed to remove many of these pressures from themselves —which may ultimately be their undoing. Technology and social support systems have enabled many individuals to survive and multiply who wouldn't have been able to without that help. We tend to view this as "humane," and at the individual level, it clearly is. Even at the species level it's sometimes beneficial, since it means that a person with great strengths in some areas needn't be lost because of a single medical prob-

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lem (though it also means that the species contains a growing percentage of individuals who couldn't survive the collapse of their civilization).

On balance, I suspect most of us would consider using social and technological support to save and nurture people with medical problems a good thing. But is it equally good to protect people without the moral judgment or emotional self-control to refrain from killing people, or the common sense to keep from killing themselves? Our courts are doing the former; many other elements in society are doing the latter.

Examples: most, if not all, states now have laws requiring motorcyclists to wear helmets. Many public schools are handing out condoms to children on the grounds that "they're going to do it anyway, so we'd better try to protect them from their own stupidity." Their henchpersons, the folks who administer the Scholastic Aptitude Tests, have recently recalibrated their scores, ostensibly to correct for sociological factors that were allegedly distorting the results. No doubt it's mere coincidence that the change makes the scores look more like they used to when more students did better on the tests—another example of making excuses instead of recognizing a problem and fixing it.

A recent AAA newsletter contained a fascinating article on the increasing problem of drivers locking themselves out of cars that are being made harder to get into. On one hand, it could be argued that drivers who can't make themselves avoid that—e.g., by cultivating the habit of always locking the door with the key—have no cause for complaint about the resulting inconvenience. On the other hand, a car manufacturer responded to the suggestion that doors should *have* to be locked with a key by saying that people would then be less likely to lock them at all, thus inviting theft.

So what? A driver who's too stupid to take three extra seconds to lock his door may learn a lesson when his car is stolen. (Yes, the thief should still be punished to the full extent of the law; an inviting target doesn't excuse crime!)

I submit the radical suggestion that we should *stop* protecting people from their own stupidity. Enforce laws against car theft, but stop pretending that it's anybody's responsibility but the driver's to guard against it. If students' academic performance is dismal, insist that they improve it—don't pad their scores so they can kid themselves that they're doing better than they are. Don't force motorcyclists to wear helmets, or give condoms to kids because they're too stupid to protect themselves even though they're old enough to know better. *Let* those too stupid to take precautions kill themselves—hopefully before they reproduce.

It used to be said that character was a matter of breeding. There's a good deal of truth in that, not only in the figurative sense of "upbringing," but in the literal sense of *breeding*. So let's breed for it—not with a deliberate program of eugenics, or cruel and inhuman punishments like sterilizing people judged unfit by other humans,

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but the *really* old-fashioned way: by simply letting people make their own decisions and take the consequences. No need to rehash the tired old argument about how much is nature and how much nurture; people's fates will be determined by what they are, whatever has made them that way.

But if we really want to breed for responsibility, we have to be sure that the lack of it *has* consequences—not just excuses. ■

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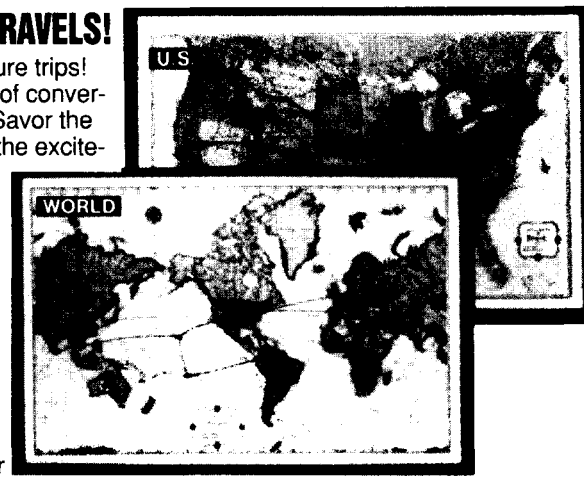

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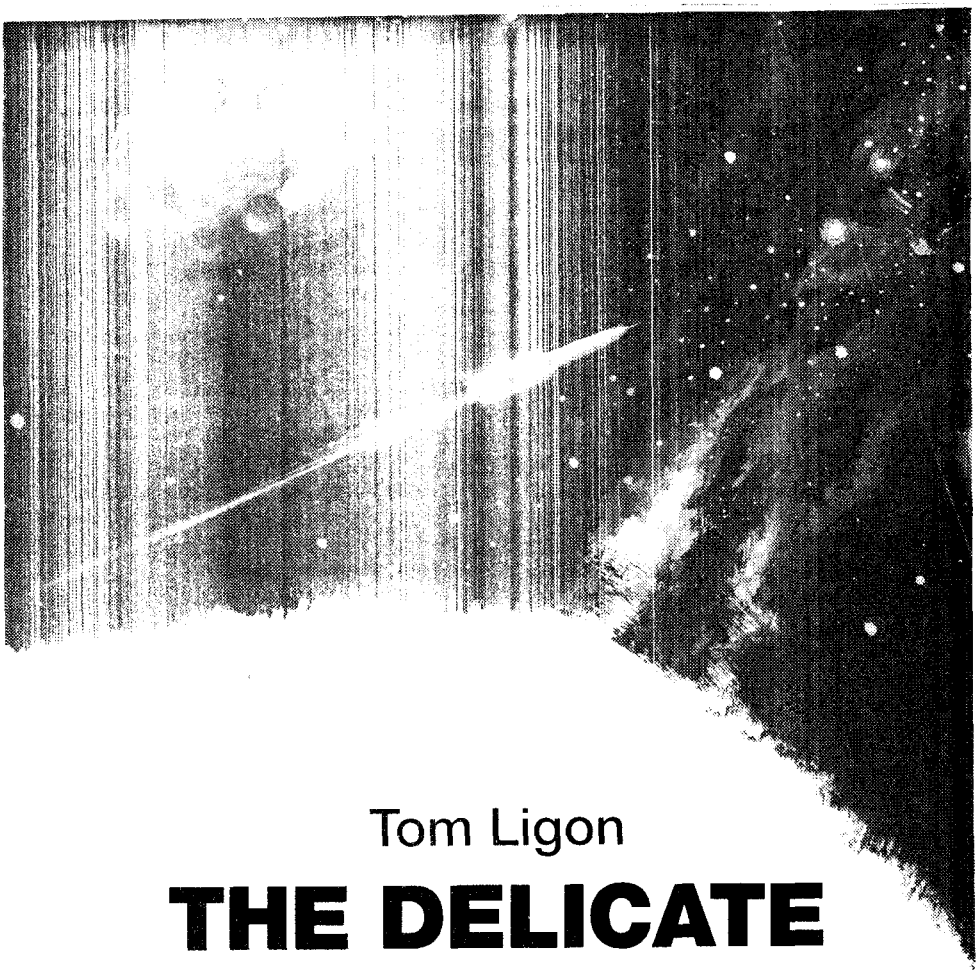

Tom Ligon

THE DELICATE CRUNCH OF MARSHMALLOWS

Some principles too often forgotten on Earth will be even more important in space. . . .

Illustration by Vincent Di Fate

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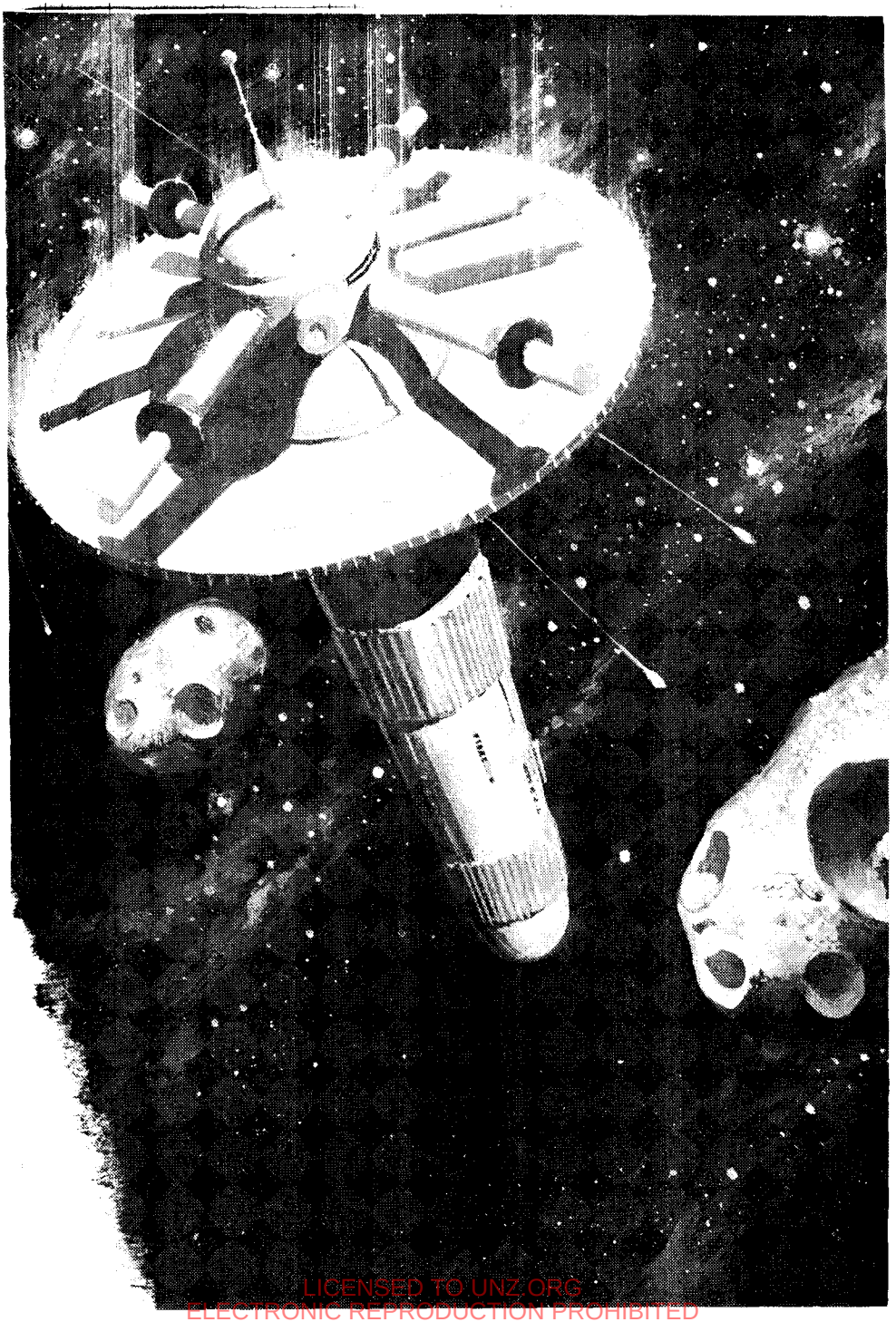

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Zerk Peterson grabbed Farouk Karis by the collar of his jumpsuit and threw the man so hard he nearly matched station spin. Farouk tumbled through the air across the shop deck, clawing for something to halt his trajectory. He snagged a fabricator with one hand and slammed ungracefully into a tool cart, cutting his forehead on a spare carbide cutter.

Farouk vaulted down from the cart nimbly in the low gravity and stormed back toward Zerk, who stood his ground. Several technologists watched in shock, uncertain of what they should do, as the two circled each other like a couple of amateur gladiators. Zerk lunged at Farouk, who dodged the attack easily. The left over energy from the clumsy move left Zerk unbalanced, and he stumbled. Farouk took advantage of the situation and planted a perfect right cross on Zerk's jaw. Zerk recoiled, then renewed his assault, and the two men locked into a clinch, tumbled onto the floor, and left a trail of blood, sweat, and drill bits across the deck.

Their co-workers finally came to their senses and separated the two combatants, who by that time were too winded even to shout genetically improbable insinuations regarding their opponent's ancestry.

"I don't want to hear your damned excuses," Erica Thompson told Zerk, still bleeding as he sat in a chair in front of her desk. "You are supposed to be a *professional,* not some brawling dockwalloper."

Zerk struggled to sit still and take it. Inside he was still seething with unfocused anger, and he was unable to find anything to vent it on harmlessly. Erica wasn't helping matters.

"Look, we've all got problems," Erica continued. "You ought to try *my* job sometime. I'm stuck between you guys and the Powers that Be. Everybody up here is bitching and moaning that they can't get what they need to build the ship, and our 'benefactors' down on Earth are screaming for my head each time we miss a milestone. The only way we can pull through this is by working as a *team.* The more we fight each other, the worse it gets. It's a lose-lose game."

Zerk started to say something, and almost choked on the words. He sat there with an excuse stuck in his throat, and could almost feel Erica's fingers squeezing on his windpipe, preventing him from purging the poison from his system. Instead of a word, a hoarse croak emerged. He broke into tears.

"Aw, fer Christsake, here we go." Erica slumped tiredly into her workseat. "Go ahead, dump on Auntie E."

It took Zerk the better part of a minute to regain enough control to speak. "I'm sorry. I don't know what's happened to me. I haven't been in a fight since grade school. It was like someone else took over. And I know the thing that set me off wasn't Farouk's fault."

"So I guess now I have to hear what it was," Erica sighed, "even if it *doesn't* make any difference. Oh, go ahead."

"My project is the main air circulator for the ship," Zerk said with a dis-

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tinct quaver in his voice. "I'm way behind, and since it gets built right into the personnel core, I've got half a dozen people's projects waiting on me. But I can't get the materials I need, and I can't get time on the fabricators, so I keep getting further behind. Then when I came down to use the time I had reserved on the fab, I found Farouk working on it. Someone had bumped me off the schedule for *his* project."

"Farouk is building form hardware for the core casting," Erica observed. "That's pretty important to the schedule, too."

"Yeah, I guess so," Zerk agreed unenthusiastically. "But I've been told my pay will be docked if my project is late. I'll admit, I've made a couple of mistakes on it, but probably 90 percent of the delays aren't my fault. It takes two hours to do a ten-minute job because we don't have the right tools."

"Then *make* the tools," Erica said firmly. "Besides, they won't dock you very much, and God knows we're all up to our ears in money with nothing to spend it on. Hey, cheer up! Think of all the money you'll have saved up by the time we get this baby finished!"

The effect that had on Zerk was the exact opposite of Erica's intent. His face shriveled into a painful grimace and turned two shades redder.

"Ah, methinks I hit a nerve," Erica commented. "What happened?"

Zerk sniffed a couple of times, then let out a heavy sigh. "All my life I wanted a piece of wild mountainside to call my own. Once I saved up enough from my earnings here, I had my agent buy a place I used to visit when I was a kid. Beautiful. About a thousand acres, bordering a lake, with a little patch of pasture for a horse or two. A place where speed is not measured in fractions of cee, and the rocks stay put instead of drifting around. Cost a bundle, but I could afford it."

"Sounds like something I used to dream of," Erica nodded. "So what went wrong?"

"Turns out the last president's mother was born there. A local group had it declared a historical landmark and sued me for an easement to it. I didn't fight them. So they put up a stone marker on this little bluff where her trailer had been, opened it to the public, and there was an accident. A little girl fell from the bluff and was crippled for life. The group hadn't bothered to get insurance, and I wasn't covered as a public park."

"Aw, geez, gawdamned lawyers," Erica snorted. "Took you for the whole damned thing, lock, stock, and barrel, didn't they?"

Zerk shrugged with resignation. "And still get most of every paycheck. Probably will until I die. Hell, I *expected* it from the lawyers. It was the judge and jury that surprised me. The judge cited me with contempt for not being at the trial in person. Didn't matter a bit that I had no way to get back from the Belt to Earth. And the jury seemed to think I made too much money for the work I was doing. Dr. Thompson, you wouldn't believe how little respect we get down there."

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"Want to bet? That's all I hear from 'em. Considering how much personal risk we each took to come up here, how little support they send compared to what they expect us to produce, and how stinking rich they expect to get on asteroid materials, I'd say we work pretty cheaply."

"I don't know. Maybe they're right." Zerk put his arms on Erica's desk and laid his forehead against them. "Maybe this whole damned idea was screwed up from the start. What idiot decided a few hundred people could come up here in a couple of habitat modules with minimal tools and build a fleet of fusion-powered ships, anyway?"

Erica hesitated before answering. "Me."

"Sorry."

"So am I, sometimes. Look, the concept is sound. This place is just dripping with raw materials. The Belt miners are only shipping back the rare earths and other high value stuff. The cost of raising materials to Earth orbit is too high for building large ships. The economics of this approach are *good*. And we'll have more help arriving in about a month."

Zerk raised his head for a moment. "Great, another week and a half lost as we lash everything down, spin down the station, mate up a pair of habitat modules, spin back up, fix everything that went out of kilter in zero *g*, and find everything that wasn't lashed down and floated into a corner. And let's not even *think* about the toilet situation. I sure as hell hope they brought their own tools."

"Yup. And everything we said we needed two years ago."

"Gee, in another two years, maybe we can get all the stuff we've been without since *then*." Zerk plopped his head back onto his arms.

"Oh, don't be so negative. Once we get the kinks out of building this first transport, things should get a lot better."

"That's not how I see it. The situation is going to hell in a handbasket, and as hard as I try, I can't even slow it down. And, you know, I'm not sure I even give a damn anymore."

Erica thought for a minute. "Tell you what, why don't you take the rest of the shift off. I'll see what I can do to work something out. You're dismissed."

When Zerk was gone, Erica turned to her computer and composed a short packet inquiry. The incoming electric rocket freighter would drop off two habitat modules full of technologists, then take on a full load of rare minerals. The ship had a small and cramped crew compartment, but they generally could squeeze in one or two more in an emergency. Erica hated to impose on the freighter crew for the eighteen-month trip back to Earth, but she didn't see that she had a choice.

Erica eased down the climbway into the mass of onlookers peering down to the deck below, where she caught a glimpse of the station MD. She elbowed through the gawkers, then clambered down the ladder.

Dr. Santi looked up as she came down the ladder. "No use hurrying now, Erica. He's been dead for hours."

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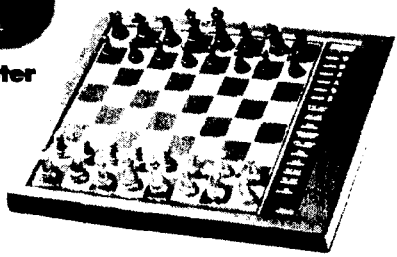

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Erica looked up at the curious technologists. "All right, you're not helping the situation. Back to work." She turned back to Buzz Santi. "Cause of death?" she whispered.

"Suicide." Dr. Santi pointed to the vents in the berth, which had plastic taped over them. "Blocked off his air, closed the door . . . then he opened this." He held up a small nitrogen bottle.

Erica glanced at the makeshift body-bag. "Who was it?"

"Zerk Peterson."

"Bloody damned hell. That's who I thought it might be. He's been having problems lately. Got into a helluva fight yesterday."

Dr. Santi nodded. "I know. I had to stitch up his victim."

Erica shook her head. "Poor guy. He was having trouble dealing with all the pressure we've been under. Turns out he lost all his savings to a lawsuit lately."

"I know. Everybody knows."

"Bad news travels fast."

"Erica, that's *old* news. You mean you just found out about it?"

"Guess I'm not on the gossip net. What I don't get is, why did he do it? I thought we'd worked out a solution."

Dr. Santi shook his head. "That's always the big mystery, isn't it? From what I know and what his friends tell me, he'd been slipping into this state for a couple of months. He'd been indicating he thought there was no way he could improve his situation. Sometimes people kill themselves because they feel continued breathing is the only thing they have any control over."

Erica nodded. "I kind of got that impression from him after our little chat yesterday."

Dr. Santi cocked his head and looked at Erica. "What really mystifies me is that everyone says he cheered up a little after your conclave yesterday. He was joking around, even with Farouk. He was talking about working out a way to get his job back on track, and making the project work. Then a couple of hours later, poof, he's in a blue funk again."

"Oh, dear."

"What do you mean, 'oh dear,' dear?"

"Excuse me, you may be right, stronger language *is* called for. Oh shit. I killed him." Erica squeezed her eyes shut and slammed her right fist against the wall.

"All right, explain that."

Erica kept her eyes shut as she slumped against the bulkhead. "A couple of hours after our little talk, I informed him that I'd booked passage for him back to Earth. It doesn't take Freud to tell me I took away the last thing he had to live for."

"Erica," Dr. Santi said after a long pause, "this is the point where the wise old doctor tells the captain that it wasn't really the captain's fault. At the risk of triggering a similar incident, and hoping you are as strong as I think you are, I won't lie to you. You came upon a fellow holding on to a ledge by his fingertips, told him you were there to help him, and then you stepped on his fingers."

"Ouch. I deserve that." She opened her eyes and stared at the medical

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assistants passing the body bag up the climbway.

"No, you don't, but maybe you need to hear it. Erica, we've had a fatal pressure suit 'accident' there was no explanation for, dozens of fights, a couple near-fatal accidents and other work injuries due to people taking stupid shortcuts, and the crew's morale is dropping steadily. We need to take a long, hard look at how we're handling this project."

"You know," Erica said, glaring at Dr. Santi, "I really hate it when people say 'we' when they're really talking about me."

The lights were out in Erica's tiny office when she heard a soft knock on the hatch.

"Come in."

Raul Otoya stepped in and paused for his eyes to adjust. "Sorry to disturb you, Dr. Thompson, but I've been running some computer models and I think you need to see the results."

Erica switched on a single work light on her desk and motioned for Raul to take a seat. "No problem. I was just trying to figure out where we've gone wrong."

"Funny you should mention that," Raul replied.

Erica directed a dirty glance toward Raul, but quickly followed it with an apologetic shrug. "You are looking, Mr. Otoya, at a sadder, but not much wiser, Erica Thompson. Between struggling to meet the schedule and worrying about crew morale, I'm flat beat. You got something to get us back on track?"

Raul started to say something and stopped to reconsider, "Well, I've made unacceptable recommendations in the past," he said, cautiously. "Can't say I've got anything new to offer in the way of solutions. I'd be happy to point out a problem, if you care to listen."

"You and about everyone else on the station," Erica grunted. "But I guess it's your job to tell me just how badly I'm fouling up. What have you got?"

Raul moved around the desk to Erica's computer. "You mind?"

Erica pushed her work-seat back. "Be my guest."

"By any chance, Dr. Thompson, do you know what the first binary digital computers were used for?" Raul asked as he typed a string of instructions.

"I may have heard it somewhere," Erica replied, "but if I did, I forgot."

"One of the first applications was for early missile projects. I think it was the old Polaris or Poseidon project, back in the nineteen fifties or early sixties. It was so complicated, at least compared to any other development program to that date, that they had to develop a system for scheduling based on critical path analysis." Raul flashed a graphic on the screen. It showed a complex parallel-path flowchart. "Each component had a lead time. Some had to be developed from scratch. Each subassembly had to be done on schedule, or it would foul up the schedule for the next higher assembly, and so on. Sometimes the process branched and came back together. Many different

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branches might need time on a single limited facility. They had to have a system for allocating resources, or they'd have half the work force sitting around twiddling their thumbs while the others were scrambling like mad."

"Hey, waitaminnit," Erica said with a scowl, "nobody here is sitting around, are they?"

"No," Raul replied, "but a lot of projects are, while the people working on them are off handling some other crisis. Anyway, they came up with a system called PERT charting, and we still use something very much like it today."

"Sounds marvelous." Erica stared at the screen dubiously. "I'd like to think a computer program can solve all our problems."

Raul struck two more keys and a graph appeared on the screen. It was low on the left, increased gradually for a while, then turned sharply up on the right and went nearly vertical. "Well, it won't always solve them, but it can sure help you spot them. The flow-chart I just showed you was our original work-plan. It is, of course, quite obsolete. I've been trying to keep up with the organization and milestone changes. Entered the best approximation I could. Turned the crank and this popped out."

Erica squinted at the graph, but was a little too far away to read the axis legends and she was too tired to come closer. "I sure hope that shows our rate of progress, but somehow I doubt it."

Raul nodded. "How very perceptive. This is an index of backlog. In most production industries, a steady order backlog is healthy. In our case, we're supplying *ourselves*, and the backlog is increasing. That's deadly. After yesterday, you can take that literally. We're down here, right where the curve starts to go seriously up."

Erica made the effort to come closer to the screen. "Oh, bloody hell. You mean it gets worse?"

"Yeah. Geometrically. And remember, the computer just works with hard numbers. It can't factor in morale."

"So how do we fix it?" Erica asked, with panic rising in her voice.

"Beats me," Raul replied. "You're the program manager. I just plug in the numbers and report the bad news."

Erica glanced at Raul suspiciously. "You some alien death-zombie body-snatcher from space? The *real* Raul Otoya never was stingy with advice."

Raul shrugged. "You've got the zombie part right. This is like some damned computer cave game where the passages keep rearranging themselves. You think you've finally mapped out the maze, and, zing, the rules suddenly change. Like you've said many times, I don't have the big picture. That's *your* job. But you can take a peek in my crystal ball, if you think it will help. If I were you, I'd spend a day or two playing around with this thing, try resetting some priorities and testing some options."

Erica clicked a few menu options from the joystick on the arm of her seat. "You be around to help if I get stuck?"

"Sure. Uh, Dr. Thompson, remem-

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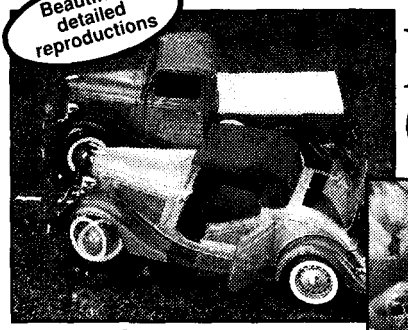

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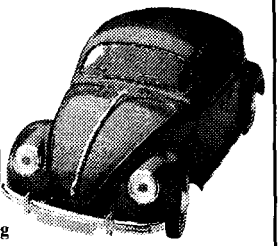

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ber GIGO. Garbage in, garbage out. Like I said, this model is short on data. First step is to get down to basics and find out what's going on in the salt mines. Mind if I ask if you've been there lately?"

Erica hadn't had her work grubbies on in months. She tried to remember the last time she had visited the project decks, or done *anything* but administrative work. It seemed like years, but she suspected it was only a few months.

The station was comprised of eight spokes rotating about a central hub. At the hub was the main construction hangar, Erica's destination. Two pairs of spokes were capped with habitat modules, offering approximately full Earth gravity for the crew during their off hours. Another pair was partly developed and awaiting the incoming habitat modules. There were two stubs where the final pair of spokes would be attached. Along the spokes were a series of shop decks where smaller components and assemblies were made. Each spoke also had a reflector/concentrator and greenhouse for growing part of the crew's food, to supplement the output of the nearby agricultural station.

The differences in construction between the habitat modules and the rest of the ship were obvious as Erica climbed up toward the hub via a series of ladders. The habitats were assembled in Earth orbit from highly refined lightweight components shuttled up from Earth's surface at great expense. Similar to Earth-orbiting space station modules, they were the product of a bloated system of contractors and government bureaucrats who had been refining the design for perhaps half a century. All told, probably a couple of million people had a hand in the design and construction of the habitat modules.

Climbing through the docking hatch into a spoke was like stepping backwards in time. Instead of lightweight aluminum alloy ladders with carefully molded composite treads, the ladders on the other side of the hatch were made of heavy asteroid steel rods bent and welded like something from a depression-era battleship. They were nicely hand-crafted though, and every bit as functional, which wasn't at all bad when you considered the tiny labor force that had built them. The battleship effect could be seen in most of the structure, although it was moderated by a light and cheery paint scheme. The structure had a satisfying solid feel to it.

Reaching up to climb another deck, Erica caught a whiff of something, glanced around to see if anyone was looking, and checked her underarms.

"Nope, it's not me."

She sniffed the air around her.

"Geez, this place smells like a damned locker room!"

She climbed through the hatch to the next deck and spotted a technologist.

"Hey, how come it smells so bad in here?"

"Oh, hi Dr. Thompson," the fellow replied, a little startled. "Uh, sorry, but the reprocessor in this spoke is busted."

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"Well, I hope they fix it soon. This is *terrible*."

The man shrugged. "We've kind of gotten used to it. I guess it does smell a little worse than the rest of the station, but frankly, the whole place is a little ripe."

Erica grimaced. "Gotten used to it? How long has it been down?"

"A couple of months, I guess. It still makes good air, you understand. Just doesn't get rid of the odor of dirty laundry and good, honest sweat."

"It may be honest, but it *stinks*."

The fellow gave Erica a long, tired look. "I'll drop what I'm doing and see if I can fix it if you want," he offered.

Erica glanced back at his lab. "What are you working on?" she asked.

"Nothing but the flow regulators for the main engines. Before that it was the APUs for the personnel decks. I dropped work on a new fastener fabricator so I could do *that*. Doesn't matter to me, though. I'll work on whatever you say."

Erica shook her head. "Stick with what you're doing. I'll see if I can find somebody else."

The fellow maintained the same tired stare for a few seconds. "Sure," he said, as if he were not, and went on his way.

Erica climbed through the remaining decks, feeling the centrifugal artificial gravity gradually decrease. It felt great, and she could hardly wait for the weightlessness of the hangar deck. The thought of almost effortless flight energized her, and the weight of her administrative duties seemed to disappear with the gravity.

Not everyone around her seemed to feel the same, though. Most of the techs labored in stony silence, broken only by an occasional outburst of profanity. Erica thought she understood how they felt, but would have swapped her duties for fighting with a stubborn bolt in the blink of an eye, if she could.

She reached the spoke airlock and labored through the two hatches to the hub. The hub was a large cylindrical compartment with one wall which appeared to turn, although, in fact, that wall was stationary while the spokes turned around it. She was about to close the second spoke airlock hatch when she rubbed against a black, gummy mass on the wall, staining a cuff of her jumpsuit. Erica clambered back through the airlock to the shop below, hung by one arm from the top rung of the ladder, and looked around until she spotted a familiar face.

"Kara, could you come over here for a minute?"

"Sure, Dr. Thompson," the woman answered. She bounded across the deck with two graceful leaps. "What's the problem?"

"What's this black crud all over the inside of the hub?"

"Oh, be careful!" Kara answered. "The only way that stuff comes out is with scissors."

Erica glared at the stain. "Now you tell me. So what is it? Two-day-old coffee?"

"Comet grease. The rotating seals were starting to break down, and we didn't have time to replace them. We

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couldn't spare the synthesizer capacity to make extra silicone grease to seal them with, so we distilled that stuff from comet tar. Plenty of it available from that little comet we snagged a couple of years ago. Seems to be working, so far."

Kara handed Erica a shop rag. "Here, this won't get it out, but at least it will get enough off that you don't leave little tar puppies all over the station."

Erica pulled herself up through the hatch, then sat on the lip while she dabbed at the gunk on her sleeve. "Oh, well, at least it looks like I *work* for a living."

Erica tossed the rag back to Kara, then made her way back through the airlock to the hub. She glanced at the gummy mess on the slowly rotating seal. It was an innovative enough field expedient, she supposed, but it surely wasn't a satisfying long-term solution to the problem. She wondered how much air they were losing, and how soon they would have to spare a team to go find another comet to replace the losses. Small comets were not all that hard to find, but they were fairly fragile, and it took a lot of time to rig a cradle to them; then gently apply enough delta-V to switch them from a headlong plummet into the inner Solar System to a gentle orbit matching the station. If they were lucky and could find one in a favorable orbit, the whole process would only take a few months. More likely it would take a year, possibly even two.

Another possible problem occurred to her, and she touched a spot near the seal. It was warm. The tarry comet grease produced much more drag than a properly lubricated seal should. That meant more power was going to the motors which maintained the spin differential with the weightless hangar. The reactor wasn't particularly oversized, and she could bet that some other energy needs were being curtailed. More important, if the motors burned out, the hangar would have to be detached from the rest of the station immediately. Failing to do this quickly was considered about the worst-case scenario short of collision with an asteroid, and Erica knew the outcome well. If the hangar began to rotate, all hell would break out inside it within seconds, and it would render the entire station unstable within minutes. They would probably have dozens of fatalities and would be set back about two years.

These thoughts were not comforting to a person standing in an area which would be outside in case of jettisoning. She sighed, then matched speed with a handhold on the hangar wall as it rotated by, making her weightless. She pulled once on the handhold to propel her toward the large hatch at the center of the hub.

The hatch of another spoke opened and a female technologist came through with a large magnet coil in one hand. "Can you give me a hand with this?" the woman asked.

"Sure," Erica replied, grinning and gesturing for the part to be tossed to her. The technologist smiled back and gently and expertly pushed the coil at an angle that neutralized station spin and sent the component di-

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rectly toward the hub. When they had first started assembly, the trick would have been dangerous, but now it was as routine as tossing a ball. Erica snagged the coil neatly with her left hand, and waited for the tech to join her at the hatch.

They pushed the coil into the airlock together, then cycled through into the cavernous compartment beyond. The hangar was an immense asteroid-steel bottle blown from raw materials by the asteroid miners who had been grinding up native raw materials for rare earths years before Erica's crew had arrived. The miners had stockpiled enormous quantities of leftover raw engineering materials, and had become adept at simple but effective ways of fabricating structures from them. To build the hangar, they had melted a generous portion of nickel-iron with fusion fire, and made the bottle in just a few days. The thick walls had glowed red hot for a couple of months. After it radiated down to merely scorching, they finished the process by cooling it with gas from comet ice. While the bottle was cooling, they built the spokes.

The hangar was one of the key economy features in Erica's concept. The zero-*g* shirtsleeve environment made construction at least a hundred times easier than it would be using pressure suits. Even with the most efficient structure a million Earthbound workers could devise, such a station would have been prohibitively expensive to launch piecemeal, then assemble in Earth orbit. The other option would be to send down materials from the belt, but if they had the capacity to move bulk engineering materials in that quantity, they wouldn't have needed more ships.

Over a year had gone into fitting the hangar for production, and even so it had the crude appearance of an iron-age industrial plant. It was brightly lit using piped-in sunlight captured by a solar concentrator, not so much to save energy as to avoid the substantial bother of making and maintaining artificial lights. The end opposite the hub was an enormous airlock. Major ship modules and raw materials could egress through it, but it also served as a work area for vacuum and controlled atmosphere work. The most important such task was blowing aluminum foam, formed by pressurizing molten aluminum with hydrogen gas.

Sections of the ship structure were under assembly, moored to the walls with cables. Small teams of technologists were busy working on the engines and crew sections, although fewer people were doing the assembly than were working on components on the shop decks.

Erica donned a helmet and jet belt. The latter was to be used only as a last resort, if you became stranded in midair with no way to push back to the walls. If that happened without the belt, it could take ten minutes of arm flapping and blowing jets of air from your mouth to propel you back to a surface. That was plenty of time for someone to get a video camera, making you the butt of jokes forever. The noisy compressed air jet belt was usually quick enough to let you avoid

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being caught for posterity, but the echoing hiss also attracted attention to your lack of skill faster.

Erica held a special fondness for the fusion engines, which were her brainchild. She headed straight toward them. A team of four technologists were attempting to mount part of one engine to a major structural brace, and it didn't appear to be going smoothly.

"Trouble?" Erica asked as she floated in range.

"Oh, hello, Dr. Thompson," one man replied. Erica recognized him as a group leader named Preston Heckmann. The others looked up for a second, then went back to struggling with the part. "It looks as if we have got another warped brace."

"*Another* one? Bloody damned hell!" They were mounting the second of the three engines. Since there was one brace of this type per engine, at least two of the three were bad. Erica would have been willing to bet the third one hadn't even been made yet. She waved at the rest of the skeletal ship. "Haven't you people learned to blow aluminum yet?"

"We're learning," he replied.

"Like hell we are," grumbled one of the men fighting with the brace. "Maybe we're getting better at overdrilling holes and shimming, but we've *never* gotten better than 50 percent yield."

The group leader frowned at the grumbler, and Erica caught the implication. She had been on the other end of situations like this, and had always known how stupid it was to insulate managers from harsh reality.

She patted the group leader on the rump. "Heckmann, how about fetching your monthly milestone reports, will you, sweetie?" Heckmann scowled at the demeaning act, but dutifully pushed off toward his cubicle to fetch his computer.

She turned back to the remaining three, who were grinning like idiots. "Now, how 'bout filling Aunt Erica in on what's *really* going on down here."

The men suddenly stopped grinning and glanced uncertainly at one another.

"Well?" Erica gestured, showing her impatience.

The man on her left raised an eyebrow. "Good example?" he pointed a thumb toward Erica as he asked the man on the far right.

"Perfect. Happens just like that." He slipped his wrench into a pocket on his right jumpsuit leg.

"Think I should tell her?"

"Why not? What have we got to lose?"

The one on the left turned toward Erica and drew a deep breath. "I suppose you sent Heckmann off so you can directly ask us some questions?"

"Yeah," Erica replied, cautiously. "So . . . ."

"Which means you can't trust him to tell you how buggered up things really are," the man on the right volunteered.

"Well, that's what I'm here to see." Erica hooked her right arm onto a conduit.

"So yuh start right in by tryin' to intimidate *us*," said the one in the middle. "Yuh know, Press usta be kinda a reg'lar guy, 'fore yuh turned

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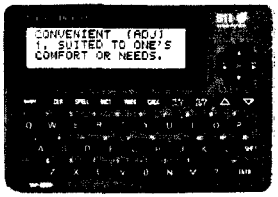

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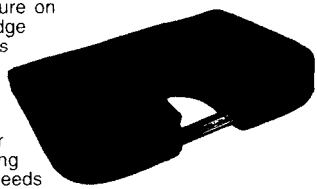

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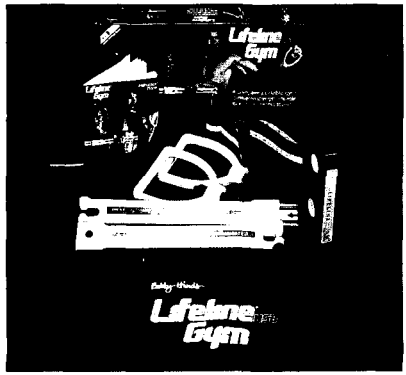

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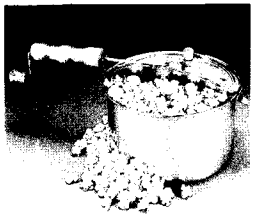

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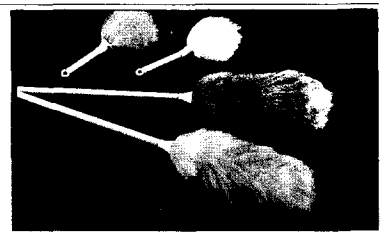

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him inta a brown-nosed lyin' paranoid."

Before Erica could respond, the man on the left chimed in, his previously barely noticeable Russian accent suddenly thicker. "In old country, is famous story of State Tractor Factory. Is so fouled up, cannot even put one nut and bolt together. At each level on way to Politburo, reports of progress get a little better. By time Brezhnev hears, is making a hundred thousand tractors a month."

"Yeah, I heard that one," Erica admitted, looking dejected. "Am I really that intimidating?"

The men looked at each other, then back to Erica, and nodded.

Erica grimaced contritely. "Sorry. If I promise to try to stop, will *you* promise to give me the straight story?"

"Sure," the Russian replied, back to his previous trace of an accent. "When this thing is finished, and we take out and crank engines up to about three-quarters thrust, the whole ass-end is going to come apart like a pair of cheap size six jeans on a size fourteen rump."

"Nah," said the man on the right. "Never happen. They'll never get the engines to *run* that well."

Erica glanced at the one in the middle, prompting him to add his two bits.

He shrugged. "Don't know *what* these yay-hoos'r moanin' 'bout." He gestured toward Heckmann, darting back from his cubicle with a computer in his right hand. "Everybody *knows* milestones is more important than a ship that actually *works*."

* * *

Erica climbed back down through the spoke airlock and looked around. She spotted Kara in a corner, one arm down inside of a large machine tool. Erica bounded over behind her. The tool was humming angrily, but didn't seem to be operating.

"Got a minute?"

"*Jee-zus H. Christ!* What now?" Kara dropped whatever she had been working on. It clattered down into the case, and she kicked the base of the machine. "Who the fuh—" She looked around and saw Erica. "Oh, sorry, Dr. Thompson."

Kara pulled her arm from the machine. Erica noticed it was striped with grease, scratched, and bleeding slightly. She gestured toward the machine. "What's the problem?"

Kara glared at the machine like she wanted to grind it up for scrap right on the spot. "Damned clutch again." She switched it off and the humming stopped. "Been acting up for a couple of years, and getting steadily worse."

Erica peered down into the works. "Is it safe to reach down in there with the power on?"

Kara shrugged. "It's either ten minutes doing that, or spend six hours tearing it down. Better than having the techs beat each other's brains out over lack of access."

Erica studied the gears, which matched the stripes of grease down Kara's arm. If the machine had suddenly started, Kara would have drawn back a nub. "Why not just *fix* it? For good, I mean."

Kara looked Erica straight in the eyes with the same tired look the first

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technologist of the day had given her. "That would be nice. But while we're dreaming, why not just finish building the upset forge and thread rolling machines we were supposed to build in the *first* place?"

Erica gestured toward the cutting heads. "Everybody told me this tool was *perfect* for making fasteners."

Kara reached over to the chuck and shook it. It rattled. "It *was*. Plus a lot of other things. In small quantities. But it is a *toolmaker's* machine, not a mass production unit. We were *supposed* to use it and others like it to build *bigger* machines, then to make small quantities of speciality stuff. Instead, we've pushed it into production service, and run it at speeds and feeds it was never intended for. Poor thing done been rode hard and put away wet. Same as the rest of the equipment we brought up."

Erica glanced at Kara's cubicle. "Can we go someplace more private? I need some honest answers."

Kara nodded, then pulled the key from the machine's power switch and put it in her pocket. On the way to the cubicle, she grabbed a shop rag and started smearing the blood and grease from her arm.

Erica closed the door. "Kara, you've been working for me for what, twelve years now?"

Kara looked up for a second. "Let's see, I started working for you at the Supercollider in . . . yeah about twelve."

"Have I *always* been an intolerable bitch, or is this a recent phenomenon?"

Kara hesitated, her eyes darting about as she considered the answer. "You've only been an *intolerable bitch for about two years*. You started becoming a *bitch* about a year after we got up here. At the Supercollider, you were the best boss I'd ever had. When you won the Nobel prize, I was so proud to be working for you I could barely stand it."

"I had good help," Erica injected.

Kara shook her head. "Machinists are a dime a dozen. Technicians, maybe a quarter. Grad students, hell, they give *them* away in cereal boxes. People capable of figuring out, from scratch, the physics behind Higgs fields, how to create and manipulate them, and how to employ them to make controlled fusion simple . . . there is only one."

Erica smiled, and shook her head. "I have stood on the shoulders of people who stood on the shoulders of giants, then stolen their lines. It bugs me that nobody seems to give *Higgs* any credit. And besides, the Higgs field work is just a spin-off of another crack-pot theory I've been cooking up. Anyway, I'm coming to the very painful conclusion that a pretty medallion does not necessarily make a very good program manager. With your help, maybe I can change that. Any ideas on where I went wrong?"

Kara sighed. "At the Supercollider, you were always on *our* side. If management made stupid demands, you always stood up for us. If we needed something, you fought to get it. I would have followed you to the ends of . . . ." Kara broke into a giggle that brought tears to her eyes.

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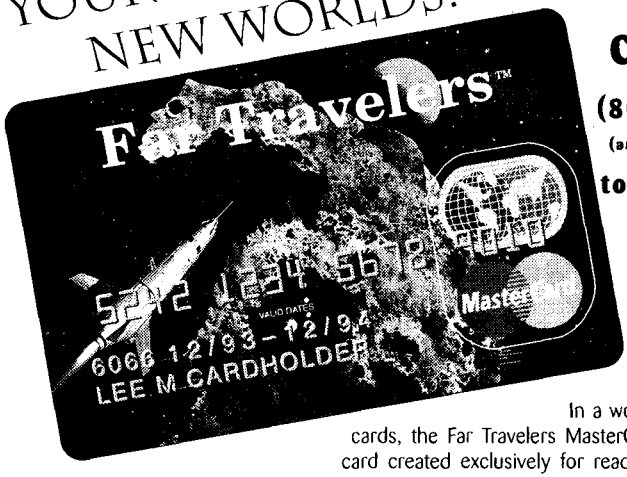

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"You followed me a lot further than that," Erica said, suppressing a snicker. She stopped suddenly. "Now I'm management, and I'm making stupid demands, and telling you to do without."

Kara stopped giggling, and wiped her eyes with the greasy rag, adding more streaks to those already on her face. "You're stuck in the middle. We know that. That's why we've been putting up with it for so long. That, and because we believe in the same things *you* do. This project *ought* to work. It *would* work if we could just take the time to do it right. But the way things are going right now . . . hell, we might be lucky to make it home alive. We need the old Erica Thompson fighting *for* us."

Erica sat silently for two minutes. "Thanks," she said at last, and slowly left the cubicle, deep in thought.

Shortly after Erica's departure, Buzz Santi entered the shop and spotted Kara, who was attempting to fish a wrench out of the bowels of a fabricator. "Hey, Kara, was Erica down here?"

"Yeah, Doc. You just missed her. She was headed downstairs."

Buzz shook his head. He spoke in a low voice. "Don't want to see her. I'm snooping around behind her. How's she doing?"

Kara looked confused. "I dunno. Got a lot on her mind. Why?"

"Something I said to her the other day that I'm starting to regret," Buzz replied. "Especially since it appears she is going around collecting bad news."

Kara shrugged. "Erica is tough. And feisty. She'll do OK."

Buzz didn't look so certain. "She's tired, Kara. From what I can tell, she feels defeated. For the first time since I've known her, she seems indecisive. I'm not sure she has any fight *left* in her. You were with her at the Supercollider. What do you know about the conditions of her departure?"

"Got fed up, and accepted *this* job," Kara replied.

Buzz raised an eyebrow. "I hear a little different story. Some people say she fried part of the Supercollider with an experiment that went wrong, and got chewed out for it. Could she have resigned under pressure?"

Kara shook her head. "Don't *think* so. At least, that's not the way *she* tells it. But yeah, she did some damage, and they chewed her out."

"What worries me," Buzz said, folding his hands, "is that Erica has known nothing but great success for most of her life, and now is facing two failures in a row."

Erica stepped through the open hatch to Raul Otoya's tiny office. "All right, what the hell is LVLPSPL?"

He looked up from his computer screen. "Low Volume Large Project Standard Productivity Level. I see you've been exploring."

Erica knotted her brow and twisted her mouth to one side, staring at him for a few seconds. "I know what that *sounds* like it means, but in that case, your numbers don't make any sense. What is it, *really*, and how do you come up with it?"

"It is a relative index of per-worker

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productivity, compared to the average productivity of similar industry as a whole," Raul replied. "The classification of 'Low Volume Large Project' is for things like high-rise construction, ship-building, big research facilities, and other labor-intensive one-off programs. The other big category is 'Industrial Mass Production,' which is totally incompatible."

"Of course," Erica replied, rolling her eyes. "But how can you compare us to a shipyard? We're having to develop everything from scratch."

"The analysis is set up to cover a wide variety of very different activities," Raul answered. "The program is fantastically complex, and the data required is prodigious. Considers everything from component count, weight, and complexity installed to kilograms of waste material produced. It seems to work, though. For instance, government-funded activities almost *always* show much lower productivity than free-market private enterprise."

"Shoo," Erica said, gently pushing Raul's chair from his workstation while pulling up another for herself. She took her seat. "Is this saved?"

Raul nodded, and Erica clicked through a few menus. She called up a graph which showed LVLPSPL on the vertical axis, and Years on the horizontal. The graph showed a steep rise from the left, an early and dramatic peak, then a gradual decline to the right. Midway across, the gradual decline acquired a distinct additional downward inflection.

Erica pointed to the early peak. "This point gives a value of five-point-two. Am I to understand that this crew was over *five* times as productive as the average of similar Earth industries?"

Raul nodded.

Erica shook her head. "I know they're good, but how can that *be?*"

Raul worked the joystick on the arm of his seat, bringing up a small spreadsheet. "I wondered the same thing myself. Nearly fell over backwards when the computer first spit that number out at me. Came up

	Here	Earth	Ratio	Cumulative
Days/Week	7	5		
Hours/Day	12	8		
Basis Hours/Year	4368	2080		
Sick Hours	-12	-47		
Holiday Hours	-0	-80		
Vacation Hours	-0	-120		
Net Hours/Year	4356	1833	2.38	2.38
Workforce IQ	140	100	1.40	3.33
Supervision Gain			1.25	4.16
Enthusiasm			1.50	6.24
Tools			0.83	5.18

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with this.

"In the first place, our crew tends to work twelve hours a day, seven days a week," Raul continued, pointing to the first section. "That's basically well over twice the hours most folks on Earth work these days. Next, they're sturdy as oxen. They were all screened for excellent health, and are in the prime of their lives. They average about one sick day a year."

Erica pulled out a calculator and checked the figures, then raised an eyebrow.

Raul pointed to several more lines. "Next, you couldn't make them take a vacation without threatening them with a stick. Every last one is a workaholic. You scared the rest off in the interviews."

Erica pointed to the next line. "Is this for real? Is the crew's average IQ *really* 140?"

Raul nodded again. "Evidently you are a very talented interviewer."

"At least I did *something* right," Erica replied. "But I'm a little humbled. My own IQ is just a few points over the crew's average."

Raul's eyebrows shot up. "You're *kidding!* I thought you must be off-scale. Well over 200, anyway."

Erica shook her head. "I make up for it with imagination and stubbornness. I see you assume their IQ gives a proportional advantage. Are you sure that's realistic?"

Raul shrugged. "It'll do for this demonstration. Seems like a reasonable trend, on the whole. I suppose morons would be better at some tedious jobs that would bore this bright bunch silly, but there are a lot of other tasks where the advantage probably varies with the square or cube of intelligence.

"Moving on, the next line has a supervision factor," Raul continued. "We had a 25 percent advantage because we needed very little supervisory time. Nobody had to be *told* to do their job. The final two lines are wild-assed guesses to fudge the results to match the overall measurements, but they seem reasonable. These people were so fired up, and believed so much in what they were doing, I figure we had a hell of an advantage right there. I figure our cobby tools and ultra-raw materials pulled us back to the final result. I should probably have factors in there for no booze, no drugs, no TV, no pesky sales reps, no kids getting sick at school, but it would be another fudge factor on top of enthusiasm, and I'd have to counter it with an even more pessimistic assessment of our tools. The point is, you can see where the productivity could come from. The numbers *are* realistic."

Erica hit a key to back the display up to the earlier graph. "If I read this correctly, now they've dropped to a total of one-point-four, despite still working about the same number of hours?"

Raul nodded.

Erica pointed to the first drop. "Not hard to figure what caused this. That's when our sponsors started getting antsy, and demanded that I show them some results they could point to. Up to that point, we were still building the facility, not the ship. They complained that we weren't

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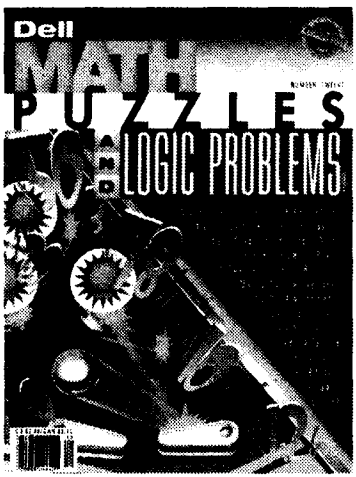

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producing, yet this shows we were really cranking it out. So I screwed around with the priorities and started building the ship."

Raul nodded again.

Erica's finger slid down the graph to the downward inflection in the middle. "Also not hard to figure out what happened here. That's when they imposed Goal-Oriented Milestone Measured Management on us."

Raul nodded once more. "Exactly. At that point, all the team leaders effectively became unproductive supervisors who's primary duty was to monitor progress against the Go-Triple-M timetable. That in itself accounts for about a 20 percent drop in productivity. It also set a schedule that had nothing to do with realistic expectations or capacity."

Erica sighed. "And I went along with it, like an idiot. I changed priorities again. In fact, I've been doing it almost daily. The work that suffered was the building of jigs, specialized manufacturing equipment for things we needed in quantity, learning to cast that damned finicky foam in large sections, and other things which would pay off a little further down the road. To meet the new schedule we had to use the toolmaker's equipment we brought up here with us as production equipment. Instead of making bigger and faster fabricators, we overloaded the little ones making bolts and widgets. Instead of building purpose-built chemical plants for bulk organics, we used the general purpose synthesizers we were supposed to reserve for speciality stuff. Down went the curve."

"Yep," Raul added. "All the while we were dipping into our stocks of replacement parts at an alarming rate. Carbide and diamond tips were being broken, and we hadn't built the facility to make boron nitride chips for replacement tools. Bearings were wearing out. Indicators were failing. When a machine was trashed too badly to be used, the load shifted to the ones that remained."

Erica stared at the screen. At last she said, "Mr. Otoya, I apologize. You tried to warn me about this. I didn't listen. I don't know what I can do to fix this screwed-up mess I've made, but, I promise, there will be some changes."

Erica got up and trudged toward the hatch. Raul stared after her. When she was out of earshot, he turned back to his computer. "Of course, *changes* are the whole freaking problem," he mumbled to himself.

Erica Thompson paced back and forth in the cramped confines of her office, stopping periodically to examine the screen of her computer. "Come *on*," she muttered. "How long does a freedom of information order *take* anyway?" She checked her watch. Even allowing for the lengthy transmission delay, the inquiry should have gone through hours ago.

The computer beeped, and she dove for it, hitting the keys before she was even in her seat. She paged through the correspondence files and reports eagerly, stopping occasionally to read parts in detail. "The scumbags," she mumbled on the average of once a minute.

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* * *

Buzz Santi knocked, thought he heard a faint reply, and entered Erica's darkened office. A single desk light was focussed on the only wall decoration, a crude and simple carving of a bearded elfish face in a small piece of oak branch. Erica Thompson had her work-seat reclined, and her eyes were closed.

Buzz began backing toward the hatch, when Erica stirred. "Sorry, I didn't know you were taking a nap," he whispered.

"Oh, no!" Erica exclaimed, waving him back in. "Just lost in thought. Bright lights make me tired after a while, and the dark clears my head. Come in."

"We were worried about you, Erica," Buzz offered. "You've hardly been seen out of your office for three days now."

"Well, sometimes I get that way when I really get involved in a project, Buzz," Erica explained. "Raul Otoya showed me a new toy about a week ago, and I've been learning how to use it. I've also been checking some records. I've pretty well figured out how we got *into* this mess. Now I need to see if I can get us *out* of it. Just took a couple of *big* steps in that direction."

"Don't think you have to do it all at once and all by yourself, Erica. Don't be afraid to ask for some help."

Erica turned to her chair to face the computer. "Don't worry, there'll still be plenty for everyone to do when I come up with a plan. Come here, I want to show you something."

Erica wiggled the joystick on her chair arm and brought up a display on the computer. Buzz stepped behind her desk and took a seat beside her. Erica gave him a lesson in production statistics that lasted the better part of an hour. The productivity graph was on-screen when they finished.

"You'll recall that shortly before the first downturn, they announced the development of solid-state sodium-proton cold fusion," Erica said, pointing to the left-hand peak. "The same basic mix of rare earths and metal oxides that make high temperature superconductors, gamma pumps, and tailored catalysts possible could also be used to make molecular-scale proton accelerators. Since these picotechnology molecules were essentially superconductors, there was already a partial Higgs field present. The electromagnetic force could be suppressed in the target node, and modifying two Higgs vectors could expand the strong and weak forces, enlarging cross sections to give better than break-even yield. Put gamma pumps around them to trap the energy, and *voilà*, portable, clean, simple fusion power.

"I remember reading about it in the scientific literature at the time," Erica continued. "I didn't miss its importance, but it seemed like a natural technological progression to *me*. I wasn't following the news in the mass media, and neglected to consider how the economics would affect us. Rare earth futures quadrupled overnight.

"As a result, an 'advisory board' approached our sponsors and con-

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vinced them that they should push ahead posthaste with the transport development project. It was gently explained to me by our sugar-daddies that perhaps we should accelerate whatever construction phases we could, to try to mollify some criticism they were getting from their investors. So, like an idiot, I agreed to try."

Erica pointed to the downward inflection in the middle of the graph. "This is where they formally imposed Go-Triple-M on us. It was proposed by that 'advisory board' I mentioned. I finally took a close look at that den of vipers, and guess what?"

"What?"

"If you made a list of everyone who wanted to build transports in Low Earth Orbit, and who argued that this scheme was unworkable, you would have the board who came up with that inane milestone schedule we've been busting our humps to meet. I've done a little back-calculating. I think they expected us to fail before this. We been doin' *good*."

Buzz bit his lip for a minute. "Well... Erica, you've just told me we've been programmed to fail. Maybe that means we've got nothing to be ashamed of, but I'd hardly say this is *good* news."

Erica tapped the left-hand peak. "Five times the productivity of comparable workers on Earth, Buzz. Look at it. How can that much talent, surrounded by plenty of energy and more raw materials than they know what to do with, *possibly* fail if you give them some freedom and get out of their way? The only limit up here is human talent, unless we allow ourselves to be held back by contrived limitations. If we stop squandering our most precious resource, I think we will succeed."

Buzz stared at the graph and pondered. "So, how do you propose to fix things dirtside if they've already got it in for us? We'll obviously never be able to keep up with their timetable."

"For starters," Erica leaned back in her seat and looked at her watch, "in about... eighteen minutes... they'll be receiving a list of grievances, naming names and citing facts, which I intend to be the basis for a lawsuit. Basically, I'm suing for breach of contract due to the imposition of new rules after we were stuck up here, and demanding that they allow us to go back to the way this place was supposed to run in the first place."

Erica winked at Buzz. "I'm really starting to like this communications delay. Waiting hours for a reply makes me less inclined to fire off a hot-headed response, like I used to."

Buzz chuckled. "The way you feel about lawyers, I'm a little surprised you're trying a lawsuit. You don't actually think you will succeed, do you?"

Erica shrugged. "Not a chance, at least in court. But it'll aggravate the *hell* out of 'em, and it may buy some time for us to prove we're right. I'd bet we could manage enough restraining orders to tie them up for two or three years. This is also going to get some media attention. I sent copies to a dozen news agencies. We've been getting some bad press, and it's time we changed that. But I

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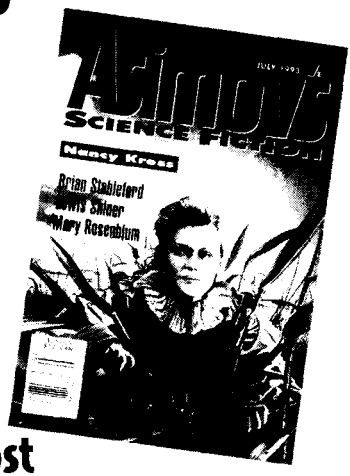

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have a couple of fallback plans."

"Uh-oh. I hear mischief in your voice." Buzz squinted suspiciously.

Erica grinned impishly. "Plan B, I'm thinking of buying each and every one of the scoundrels a copy of Heinlein's *The Moon is a Harsh Mistress.* Give them something to think about."

"Erica, you *wouldn't?*"

"Buy them classic reading material? 'Course I would. Then there's plan C. We ignore 'em."

Buzz blinked a couple of times. "You might want to *think* before you cut the umbilical cord . . . ."

"Oh, come off it, Buzz. How many science fiction stories have you read where the colony had to do this very thing? *Every* author has at least one. This was so predictable, I'm ashamed I didn't see it coming. *Had* to happen. It's just human nature.

"Sure, we need stuff," Erica continued. "Been needing it since before we got here. Haven't been *getting* much of it, and when we do it's two years late. We generally find a way to make it ourselves. And maybe they'll cut off our pay. So what? We can't spend it up here anyway. And I know we could have the first ship built *way* before they could, far cheaper, with more copies sooner. Hell, if we have to we can go independent and *sell* 'em the damned ships. They couldn't say no. The whole bloody world economy may *collapse* if they can't supply rare earths for the energy industries."

Buzz grimaced. "Well . . . we aren't *absolutely* self-sufficient. I suppose we can get by indefinitely on the so-called food we raise, but I know a lot of our coworkers want meat culture equipment so badly . . . I was going to say they can taste it, but the problem is they *can't.* And maybe half of my medical supplies are produced by proprietary genetic engineering. I couldn't duplicate the technology in twenty years. I'd need their cultures."

Erica considered his arguments for a while. "If we have to, maybe we could fund our own mission. Better yet, we could whip off a smaller ship and go get the stuff ourselves. But, let's face it, most things we'd be doing without, the Jamestown settlers had never even dreamed of. OK, so they had meat. Geez, what I wouldn't give for just *one* bacon cheeseburger right now."

"Erica, I'm really starting to regret bringing up the subject of meat," Buzz lamented, patting his belly. "Let's get back to the main topic. Assuming we can get these monkeys off our backs, do we really have what we need to finish this ship, or are we ignoring another problem?"

"We could really use more people," Erica said thoughtfully. "Even with the new crew, if they don't launch the last pair of habitats, we'll still be about 25 percent understaffed, mostly astronics specialists. We could end up with a big, dumb brute of a ship, but I'm confident we could whip up a good enough system to make it fly. Hell, we're not trying to build some fancy, over-engineered techno-money-hole like those idiots who're giving us all the trouble want. What we're building is the DC-3 of space. We just want a simple, solid, reliable transport that's quick enough

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to do the job and economical to operate. Meanwhile, the jerks dirtside would be cutting their own throats. They'd be slowing us down, and they'd have to wait longer for the ship. That's a lot more of a problem for *them* than it is for *us*."

Buzz nodded.

Erica continued. "One more *big* problem."

"What's that?"

"I'm a *lousy* manager."

"I dunno, you've—"

"Damned near run this outfit into the ground with all my freaking fiddling and reprioritizing. Buzz, before I took on this project, I'd never supervised more than a dozen people at one time. I was strictly middle management, and I bitched long and loud when the folks at the top got priorities screwed up with politics. Then I won a Nobel prize, and suddenly everybody, including myself, figured I could handle *anything*, even taking a small crew to the far reaches of space to build the biggest, fastest rocket mankind had ever created.

"I've done things that I *swore* I'd never do. I've talked people into making do, used up our capital equipment, and jerked folks from one task to another until they think the most important job is the last one they were bitched at about. They've accepted stupidity as Standard Operating Procedure. No *wonder* morale is so low. Every *one* of them was smart enough to know what a crock I was handing them. The only wonder is that they've gone along with it instead of handing it back to me."

"Inverted!" Buzz grinned, picking up an empty coffee mug and holding it upside down.

Erica returned the smile, took the cup, and held it over her head. " 'Bout here." She turned the cup back over, looked into it, and sighed theatrically. "Know what I really miss?"

"Real coffee," they said in unison, and sighed again.

"Come to think of it, I think every science fiction author predicted *that*, too," Buzz observed.

Erica leaned back in her seat and swiveled it so she could gaze at the little carving spotlighted on her wall. "And I miss working with my hands. I can remember carving that as a kid, in summer camp."

Buzz closed his eyes. "Summer by the lake. Sailing in that silly little boat that always had the most dubious-looking green stuff growing under the floor."

"Spring's 'golden hour.' "

"Birds in trees."

"Cats, sitting in windows *watching* birds in trees."

"Thunderstorms, watched from a warm, snug house."

"Getting dressed up and going out to a fine restaurant."

"For a good steak, with broccoli and a real baked potato."

"One thing I *don't* miss is my relatives asking me when I'm going to start a family," Erica said with a scowl.

The doctor nodded. He knew her medical history.

"But, God, do I miss kids." Erica's voice cracked a little as she said the last word.

"Skiing," Buzz offered to lighten the mood.

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"Snowball fights," Erica countered. "Sunrises . . . ."

". . . And sunsets."

Erica sat quietly for half a minute, looking longingly at the little carving. "What I *really* miss, more than anything else, is sitting around a campfire telling spooky stories, smelling smoke and enjoying it instead of wondering if we're all about to die, listening to all the little sounds in the woods, watching the stars, spotting satellites passing by, and preparing the most exquisite delicacy known to mankind."

Buzz nodded. "Premium grade kosher hotdogs."

"Huh! Carnivorous cretin!" Erica huffed. "There is nothing, not even the puffiest French pastry, which can compare to the daintily delicate crunch of a *perfectly* toasted marshmallow. Buzz, you are looking at the world champion marshmallow toaster."

Kara had just picked up a tray when she spotted Erica Thompson at a corner table, pushing overcooked peas and mashed potatoes around on her plate. Kara studied the physicist, remembering the firebrand who had once made science fun. Erica looked much older now, and so tired.

Kara ladled out an assortment of allegedly nutritious vegetables and a lump of something off-white (rice or grits, hard to tell). She stood at the end of the line for a moment, wondering if she should voice her concerns. Finally, she strode over to Erica's table.

"Mind if I join you, Dr. Thompson?"

Erica looked up, surprised. "Oh, not at all. Please do, Kara." She paused for a moment as Kara sat down. "And, Kara, do you mind if I ask why you don't call me 'Erica'?"

Kara cocked her head slightly. "Institutional habit, I guess. The unwritten law at the Supercollider. Sign of respect."

"Humph." Erica rearranged her peas some more, staring at her plate. "Homage to people with advanced degrees? Kara, do you realize you are smarter than me?"

Kara was startled by the remark. "That's not true, and you know it."

Erica looked up from her plate. "Oh, but it *is*. I just saw your test scores. Your IQ is five points above mine."

Kara choked on a spoonful of carrots. "You're *kidding*," she managed after swallowing.

"You, and a nearly a third of the crew," Erica replied, returning her gaze to the potatoes. "This place is a damned Mensa convention. Who do I think I am, anyway, trying to tell a crew as smart and resourceful as this how to do their jobs, anyway?"

"Somebody has to run things," Kara replied. "They picked you because you had credentials that brought respect."

Erica poked a tunnel in the cold potato paste and herded the peas into it. "That may all be behind me," she lamented, bringing down the roof of the cave on the peas. "Just did something we all may regret. Filed a lawsuit against our sponsors. Probably get us all fired."

Kara blinked, at a loss for words.

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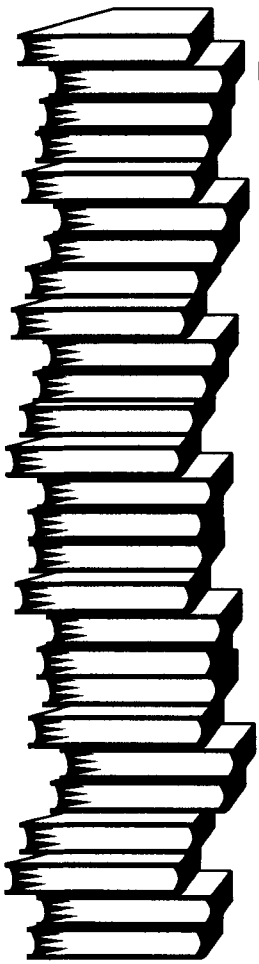

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"Well?" Erica looked up. "Come on, say something positive, like you usually do."

"It's about bloody time," Kara stated. "How's that?"

"That'll do."

"Welcome back, Dr. Thompson. We've missed you for a *long* time."

"Erica." Erica grinned.

"OK, Erica." Kara took a bite of beans and chewed them thoughtfully. "Um, Dr. Santi was asking about you the other day. Sort of got me wondering about some things."

Erica picked up a forkful of the trapped peas and shoveled them into her mouth. "Buzz playing mother hen again?"

"Yeah. He was worried that you might be taking this kinda hard, especially after that incident at the Supercollider. Wondered if two failures—I mean problems—in a row were getting you down.

Erica looked up suddenly. "Two failures?" She hesitated for a second, then guffawed suddenly, sending little bits of peas and potatoes flying. "Mmmmph. Sorry, here, have an extra napkin. Kara, I won't say I've been a bang-up success *here*, but what happened at the Supercollider was *anything* but a failure. Maybe I'll tell you about it someday."

Kara studied Erica, whose eyes had suddenly developed a twinkle.

The following message was broadcast to all computer mailboxes on the station:

Dear Colleagues:

A lot of you will read that opening and groan. The last time you got a memo from me with that opening, you followed me up here.

You have my apologies for how badly things have turned out lately. I think my first line then was something to the effect of, "I quit." But I wasn't management then, nor was I responsible for screwing up the program. Now, I am. Therefore, I hereby fire myself from the position of program manager, effective one week from today.

I am appointing Raul Otoya as my replacement. That'll teach him not to bitch. You should all give him your condolences when you see him.

Since we haven't built our transportation home, I guess I'll have to stay here. That means I'll need a job, preferably one that will keep me out of your way and make enough use of my abilities that I rate my breathing air and ration of mush. I think the perfect position is something along the lines of "Researcher Emeritus and Wizened Advisor" so that's what I propose to be.

In my last week, I hope to set in motion some changes which, with Raul's skillful management, will hopefully get us back on track. The first step in this is to order a general shutdown of all construction on the ship.

The only job-related work to be done for the next two days will be whatever is necessary to keep the station life support running safely. Everyone is to take two days off to catch up on sleeping, laundry, reading, pursuing the opposite sex, and any other essential personal activities that you have been putting off for several years.

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The remainder of the week will be spent fixing and building stuff to make our lives more pleasant, and getting ready for a picnic which will be held seven days from today, at Zulu noon, to celebrate my firing. Either bring an amusement or contrive some sort of interesting food dish in sufficient quantity to assure that we are all suitably overfed. Raul, you can work out the details.

The succeeding six months shall be spent repairing, building, and improving the production capacity of this facility, with such efforts to continue as needed to assure the most timely completion of the first transport.

My final official act will be to leave you with the following set of general operating rules for the project.

THE RULES

1. Our mission is the construction of transport category spacecraft. All useful work to this end is done by the technologists. Team leaders and administrative officers exist solely to support the technologists in the accomplishment of the mission.

2. It shall be the duty of all employees to remind team leaders and administrators of Rule 1 as frequently and firmly as it takes to assure that it is followed.

3. No person is to work more than forty hours per week directly on the construction of spacecraft. Those wishing to work additional time toward the mission may work on improving production equipment, methods, and capabilities. Extra work is also permitted on improving the general standard of living, research and development of new technologies, and other worthwhile efforts.

4. All employees shall be required to use accrued vacation time in excess of one week for each year of service. Employees found violating this provision shall be forcibly ejected from their work-place by their fellow employees, with the following express orders: "Enjoy yourself." This order shall be phased in over the next twelve months, on a rotating basis to be worked out among yourselves with a minimum of bloodshed.

5. All employees are encouraged to develop sideline businesses providing food, luxury, convenience, amusement, housing, and similar items for barter credits, to be pursued in spare time, provided these activities do not interfere with normal duties. Technical items for trade with other Belt production facilities may also be produced. Goods and services for transport production normally a part of employment duties shall not be permitted as barter items. To facilitate this activity, the station shall provide, at nominal charge against salaries, such surplus materials and production capacity as are available and appropriate.

6. Every time you do a task, try to find a way to do it better than before.

7. Bad ideas are not to be adopted as policy or put into practice.

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8. Anyone caught using the acronym GOMMM, the phrase it represents, or any variation thereof, in other than a derisive context, shall be required to recite Rule 7 a minimum of 500 times. For the first offense.

9. All employees shall, on company time, spend five minutes a day looking out a porthole and appreciating just where it is that they are. Pretty wonderful, ain't it?

10. Build the best damned spaceships you can.

Buzz entered the safety cubicle wearing a faded T-shirt and shorts, instead of the usual jumpsuit. "Raid!" he yelled, causing the two poker-playing technologists to scatter their cards and chips.

"Sir?" one said, amidst a slow rain of cards in the light gravity.

"Just kidding. I'm six months overdue on a safety survey. Thought I'd get it out of the way." Buzz slipped into a seat at the monitor console and began testing the system.

The console was computer-monitored, but also had direct fail-safe indicators for critical fire and air circuits. Partway through the survey, Buzz found an indicator which would not respond when queried. He pulled the panel, and found a bypass jumper.

"What the . . .? Who screwed with the gas detector in Chem 5?"

One tech came over to look at the jumper. "Beats me, sir. We're standins. Only been here a couple of hours. I could see if anyone's got the lab reserved."

"Do it," Buzz ordered as he pulled the jumper. The circuit responded with an immediate alarm condition. "Oh hell. What does that mean?"

The computer answered. The sensor was non-specific, but was detecting significant quantities of abnormal compounds in the air, possibly toxins or combustion products.

"Sir," the tech reported, "Dr. Thompson has had that lab reserved for two days."

"Damn!" Buzz grabbed a breathing mask and a fire extinguisher. "I should have kept a better eye on her after that memo. I hope she hasn't done something stupid. Come on, grab your gear." Buzz pressed a silent alarm to page a replacement emergency team.

Seconds later, they were two decks down, outside the chemical instrument bay from which the alarm originated. Buzz cautiously touched the door to see if it was hot, then pulled the handle and opened it a crack. No smoke emerged. "Doesn't look like a fire, anyway."

Buzz handed his fire extinguisher to one of the safety crewmen, switched on his air-quality monitor, then checked the fit of his mask. He pulled the door open and stepped inside. His two assistants followed with fire extinguishers.

Erica looked up from her work, annoyed. "Damn! I thought I'd deactivated the alarm."

Buzz looked around. Nothing was burning, but Erica was hiding a tray in a drawer under the bench. On the bench was an electric hot-plate

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which was running orange-hot and producing a thin curl of smoke. He pulled his mask back and sniffed cautiously. It *almost* smelled like wood burning. He pulled the mask off. "Damn, Erica, that's what had us worried. After that thing with Peterson, I dunno. I just thought—"

"Thought I might be doing myself harm? And miss this picnic? Buzz, are you out of your ever-loving *mind?* Do you *know* some of the stuff people are fixing up for it?"

"Well," Buzz paused just a second, "I've been smelling all sorts of interesting stuff cooking."

"You hear about the hot tub?"

"Just rumors. There's also some wild talk about raiding the peanut oil stocks and heading for the hangar. Oh, and a couple of techs are building what looks like a dunking machine. The target flapper is marked 'Rule 2.' "

"Uh-oh. Wonder who that's for?" Erica winked. She pointed to the firefighters, and a small crowd of curious on-lookers gathering outside the hatch. "Chase those nosy rascals out of here and I'll show you the top secret project *I'm* bringing."

Buzz turned to his assistants, shrugged, and shooed them outside. When they were gone, he turned back to Erica. "Campfire?"

"Even better." Erica retrieved the tray from the drawer. It contained a stick and a sheet-metal mold. She plucked a white object from the mold and skewered it on the end of the rod. "We may be a little limited in fancy food up here, but we sure as shootin' can come up with a little sugar and starch."

Buzz moved closer. "I'll be damned."

Erica put a drop of liquid on the burner, which produced a puff of grey smoke. "You'll be blessed. I'm still working on the smoke. I've managed to synthesize most of the components, but I think there must be some sort of catalysis going on involving glowing coals that I'm still not getting. Here, hold this. Not too close. That's it, now rotate it at about two RPM."

Erica positioned a sniffer over the burner, then picked up a cylindrical piece of wood with gouges in it and prepared to shave off another piece.

Buzz recognized the carving from Erica's childhood. "Erica, *stop!* That's too precious to burn!"

Erica turned the carving over and glanced at the face on the other side. "What? This piece of junk, precious? Buzz, I'm flattered, but I'd burn it to a cinder if I thought it would help morale up here. Don't worry. Truth is I never finished it. The back is *supposed* to be *flat.*" She dropped a wide sliver onto the burner, and it burst into flame momentarily. "But don't waste it! There, that's right. Not so close! Now, it's *perfect.*"

Buzz pulled the marshmallow away from the burner and admired it.

"Not bad, for an amateur," Erica observed. "With my help, of course." She turned to the gas analyzer. "Got something here. Computer doesn't have a name for it though." She reset the instrument and put another sliver on the burner.

Buzz touched the golden crust of

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his prize and determined that it needed to cool a bit. "Erica, if I'm not mistaken, somewhere in inventory we've got a couple of dozen two-by-fours."

"No good," Erica replied without taking her eyes from the analyzer's display. "Aircraft-grade fir. Terrible for cooking. Besides, they're emergency supplies. Don't worry, I'll get this."

Buzz plucked the delicacy from the skewer. Erica turned to watch as he cautiously placed it in his mouth. He bit down, and smiled as broadly as good manners would allow.

"How was it?"

Buzz savored the flavor before answering. "Erica, that was *terrific*. I don't remember ever eating one that was so *light*. And it tasted sort of . . . I don't know . . . ."

"Fruity?"

"Yeah, sort of."

"That's because we don't have corn syrup. I used a mixture of sugars which is mostly fructose. Primarily because the sugar we *have* is mostly fructose. And they're about twice as fluffy as any commercial marshmallows, due to my secret process, which I will not reveal, although, if you keep in mind where we are, you may find a few clues. Also, I use just a trace of peanut oil to keep them from sticking to the mold. Notice how that improves that oh-so-delicate crunch?"

Buzz nodded. "Absolutely. A masterpiece, my dear. I'm sorry I said what I did about hotdogs."

"You're forgiven. Especially if you've found a way to whip up some kosher franks for the picnic."

"Sadly, no." Buzz hung his head. "Even if I could, perhaps it would not be wise for the station sawbones to suddenly show up with meat."

The comment struck Erica cold. She lapsed into a distant stare and did not reply.

"Oops," Buzz said as he recognized his blunder. "I didn't mean to bring up painful thoughts. Forgive me."

"You're not the one who needs forgiving, Buzz. God help me, I'm a heartless bitch. Here I am joking and fixing these silly balls of goo, after I killed a man." Erica's chest heaved.

"Enough of that," Buzz ordered. "Forget what I told you back then. Zerk Peterson did *himself* in. You failed to help him. I failed to help him. His co-workers failed to help him. But we're no more to blame, and probably less so, than those lawyers who cleaned him out, and those consultants who came up with GO—oops, almost said it."

Erica looked up, a trace of a smile showing at the corners of her mouth. "Thanks. You can say it. I'd have counted it as derisive."

Buzz grinned. "I'll play it safe until I find out what the *second* offense brings."

Erica plucked a pair of fresh marshmallows from the mold, while thoughtfully considering the issue. "Hmm, I wouldn't think there'd be too much need for additional punishment. I'll have to give it some thought. A punishment to fit the crime, and one as ridiculous as GO . . . whatever. A pillory, perhaps?"

Buzz arched an eyebrow, then nod-

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ded. "Both equally effective in keeping us from doing our work, I suppose. Speaking of punishment fitting the crime, Erica, you were *awfully* rough on yourself in that memo. Do you really think firing yourself was called for?"

Erica laughed. "Oh, God, Buzz, I can't tell you what a *relief* it was to have an excuse to quit! Once we got past the design stage and down to the nuts and bolts, I was absolutely *miserable*. I belong in a lab, dreaming up stuff the mundanes think is impossible. I was working on something on the Supercollider so wild it would knock your socks off. Time to get back to it."

"OK," Buzz conceded, "but you took the blame for everything that went wrong. That's not fair."

"Doesn't matter. I'm to blame for enough of it, and I don't mind shouldering the rest, especially when I only have to carry it to the nearest airlock and dump it. Poof, its gone! The only aftereffect is that hopefully I will never be asked to take such a job again."

"Yeah, but those bastards—"

"Are at least as much to blame as me. Yeah, I know. But what I'm trying to do is put this mess behind us by ignoring them. I don't want to encourage the crew to grouse about dirtside management. I want them to take charge of their *own* destinies. Which, by the way, they failed to do, making the fault a little bit theirs, too. All in all, I'd rather everyone just nod, agree that I've done the right thing, and pick up where we were in our innocent glory days."

Buzz thought about it for a moment, then nodded agreement. "While we're on the general subject of the memo, I was sort of wondering about some of those rules. One, two, and the last five are easy enough to understand. Forced vacation, sure, to prevent burnout. But can we get the ship built on time with just forty hour work-weeks?"

"Nope. We'll be about a year late according to Raul's *original* schedule," Erica said with an evil smirk. "Serves the greedy sons-of-bitches right. *Their* way would have probably taken fifty years, if Raul's prediction was right. Besides, down the road, I think they'll get the rest of the ships *sooner* than we'd originally projected. Rules three and six are intended to encourage improving productivity, something this crew should do *exceptionally* well."

"OK," Buzz acknowledged, "but what does this rule about outside business have to do with building the ship?"

"Not one damned thing," Erica replied. "It's a promise I made when I invited my co-workers at the Supercollider to join me up here, and which I conveniently forgot. It has to do with building a life. It has to do with rewards we can touch, instead of fat bank accounts with vultures hanging over them ready to take them away. It has to do with living in a reasonable facsimile of a home, instead of a shoebox in a numbered habitat module. Except," she winked and touched her right index finger to her temple, "just *maybe* things like that could perk the enthusiasm factor

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up a notch or two."

Erica sliced off a generous sliver of wood, then turned the lights off. The lab was lit only by the glow of the burner and the display and indicators on the analyzer. "Ah, there, I knew part of the effect was missing." She held her confections over the sweet spot of the burner.

"I wonder if I have time to come up with a credible chocolate bar?" Buzz mused aloud. "And Kara knows how to bake. Maybe some graham crackers?"

"Mmmm." Erica smiled contentedly. "Life is good, Buzz. Everything is so *perfect*."

Buzz cocked his head slightly. "I don't know. There's light at the end of the tunnel, but *perfect?*"

Erica nodded. "Perfect. I'm in space, learning to build spaceships. I'm exactly where I should be when I need to be there. Kara told me about your concerns. It reminded me of why I took this job. If you promise not to tell, I'll let you in on a very special secret."

Buzz crossed his heart.

"I didn't exactly *fry* part of the Supercollider, Buzz. I damned near blew it up is what I did," Erica continued. "I was testing a theory I've been working on since junior high. Lost all my data except for the most important part. I found a new form of energy. Just when it was becoming obvious that my tests, on any useful scale, would have to be continued in space, I received this job offer. I figured I might just get a chance to continue my research up here, away from prying eyes and interference, and use my discovery to build a much faster ship."

Buzz looked up from the marshmallows, just beginning to form a faint golden crust. "Criminy, Erica, the thing we're building will already drop transport time by a factor of *six*. How much faster do you need?"

Erica leaned over the burner, watching for exactly the right moment. "Depends on where you want to go, Buzz," she said, pulling the sweet morsels away from the burner. "Instead of months, what if we could make the trip in *minutes?*"

Buzz frowned. "Come off it, Erica. Even at nearly the speed of light, it would take around an hour."

"True, Buzz," Erica said, smiling slyly. "But that limitation doesn't apply any more. There is a faster form of energy."

Dr. Santi's jaw went slack, and he stared at Erica, trying to comprehend the magnitude of what she was saying. She slipped a marshmallow from the skewer and into his gaping mouth.

"Don't bite down, it's still pretty hot," she warned. "No promises, you understand. Hell, I have my doubts I can build a ship that can withstand it, much less if the people in it can. Like I said, I've only run one good test, and it demolished the detectors. But stick around. Things could get interesting up here." ■

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Probability Zero

THE WAY OF FLESH

Paul Levinson

I walked up to the podium and blinked in the bright lights. The audience in front of me seemed as far away as the larger audience on the thousand inhabited worlds in our net.

I cleared my throat and began.

"One of the central mysteries that yet eludes our understanding is the sudden dissipation of seemingly robust civilizations. On too many planets we find what looks like a thriving culture—with spires as high and as intricate as those on our own worlds—abandoned with barely a trace of the intelligent life that built them. It's almost as if everyone went home for lunch and never returned.

"Our usual assumption in such cases is disease or some other physical culprit—a dramatic change in climate, for instance, that might have rendered agriculture and aquaculture unproductive.

"But recent evidence uncovered by my colleagues and me on a distant planet have suggested another cause.

"This was a planet which had achieved some global cooperation after centuries of bitter warfare. Its scientists were on the way to comprehending and manipulating reality on a subatomic level. Rearrangement of DNA in natural living patterns was just beginning to be used to literally improve the quality of organic life. Artificial intelligence had yet to be implemented, but visionaries were well aware of its benefits. Most sadly of all, this species had made the first groping efforts to propel itself beyond the confines of its planet.

"What went wrong?

"Serious diseases were not the cause. This planet had more than its fair share of them, but its species also had resilient immune systems, which were able sooner or later to come up with effective antibody responses. And these of course were helped by the diligent work of their scientists.

"Nor were shifting climate conditions the cause. Many people in this

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civilization were concerned about climate shifts due to technological effects, but these proved far milder than feared.

"What we did discover was something more insidious—a quite deadly social attitude.

"It first appeared, as best we could tell, some time near the end of what the civilization reckoned to be its second millennium. Almost imperceptibly at first, but with astonishing pervasiveness, members of the species in the most advanced precincts of the civilization were made to feel uncomfortable about relating to members of the complementary sex in the workplace, in schools, everywhere.

"Legal embodiments of these attitudes soon followed. On the eve of the second millennium, flirting was declared in many municipalities to be a misdemeanor on a par with littering.

"Then smiling in public was declared an obscene gesture—a statute that was taken up in the next national election, and endorsed in laws governing Federal interstate commerce.

"In a particularly telling series of court cases, the words 'I love you' were held to be vulgar and obscene—first when uttered to another member of the species in public without that member's express written prior permission, soon after when uttered any time to anyone other than one's own family.

"Then things got even worse.

"Children were particularly susceptible to such public pressures, and they inevitably brought these attitudes home. Soon they felt uncomfortable expressing love—by either hugs or words—to their parents. And their parents—unable to cope with the cold chickens they had brought home to roost—responded with hurt and anger.

"Children reared in such drab, loveless environments were, not surprisingly, unable to form loving relationships and families of their own when they came of sexual age. This in itself might not have been fatal to the species—reproduction, after all, can easily take place without love and family—but the poisoning of all flirting, even via glances of the eyes, took the edge off sexuality in all its forms, the unsanctioned as well as the dwindling sanctioned.

"Reproduction rates plunged catastrophically—giving new meaning to what some members of the species had called the 'population bomb.' Children themselves, the obvious evidence of despised sexual activity, became an embarrassment, a segment of the species to be hidden from view, when they existed at all. Only offspring emerging from various means of artificial insemination were considered acceptable. But the means of producing even these were already in decay.

"For the workplace had become a dungeon of boredom. Without the bright sinews of repartee between the sexes—devoid after a while of even the rich internal fantasy fanned by the occasional flirtation or hope of one—work became unbearable. Absenteeism skyrocketed—even among the very scholars and public critics

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who might have yet observed and stopped this deadening phenomenon.

"But it was too late. With the air let out of its balloon, with birthrates far below the minimum level needed for species continuance, this once vibrant world shriveled to the deserted buildings and videotapes we found on our arrival—old videotapes from a happier time, locked in vaults that for years had been the only place where a smile or a loving gesture could be seen. The species had simply given up."

I ended my paper and soaked in the mixture of applause and awe that came from the audience.

I opened the floor to questions.

The spotlight shone on someone three rows back. I couldn't help noticing her soft purple burnish and lake-like eyes as she smiled at me. "Could you give us more details, please? Dates and places?" she asked.

I smiled back, and called up some data on the big screen. On sudden impulse, I also sent her a one-liner in sublingual private text mode. *How about a bite to eat after this?*

She busied herself looking at my data. A cool customer, this one. But I thought I noticed a small upturn at the corners of her smile.

Love to, she answered via private text.

A thrill hummed through every panel of my circuitry. One of the best things about my job was the high profile and entree it gave me to female models of like construction and mind. ■

Doing science is very different from doing the arts. Science is difficult. You need mathematics and statistics, which is dull like learning a language. The difference is that with a human language each word you learn you can use. In science you can work away for months and nothing happens. The arts intrinsically appeal to the human soul but a lot of science doesn't, and a lot of science is incredibly boring to do.

——Richard Gregory

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Donald Kingsbury

The Janus-Headed Arrow of Time: Entropy and Time Travel

It is remarkably liberating to realize that time in itself does not exist except as an abstraction to free us from always having to talk about this clock or that. The discovery that there is no time—only clocks—has deep and surprising consequences for many very simple things we tend to take for granted because of our almost instinctual conviction that time has a reality that transcends the behavior of clocks.

N. David Mermin, from his book *Boojums All The Way Thru.*

We all know in our hearts that time travel is impossible—much as we'd like to chat with our younger father or fight the lions in the Colosseum with our trusty AK-47. But the proof of such a mundane intuition is not easy to come by. We listen to convincing time paradoxes—yet retain an uneasy feeling that paradoxes are logical constructs that may be telling us more about our untenable basic assumptions than about the nature of the physical world.

So why *is* time travel impossible?

CLOCKS AND ENTROPY

"Kingsbury's Entropy Theorem," which I have modestly named after myself because of its elegance, states that it is impossible to build a clock which can distinguish between backward or forward time flow. This is because all clocks are entropic in nature. If we could build a clock that ran backwards simply because we reversed the flow of time, we could also build a perpetual motion machine to

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generate as much power as we might ever want—for free. A two-way clock necessarily transcends the laws of thermodynamics.

Time travel is *not* impossible because physics prohibits time-reversal. Time travel paradoxes are cute but irrelevant. Time travel is impossible because no conceivable clock would ever be able to reverse itself even if we did have a machine that could alter the direction of time.

Reverse time—and the sand in an hour glass will continue to pour from the top chamber to the bottom chamber. The sand will *not* start to flow upward in such a way that entropy begins to decrease. Even time-reversal cannot put Humpty-Dumpty back together again.

Reverse time—and the velocity of a pendulum will reverse. But the grandfather clock's hands will continue to rotate clockwise. To get the hour and minute hands to run counterclockwise would require us to redesign the clock so that in normal operation its entropy would be decreasing. We'd have to ensorcell a Maxwell Demon. The driving weights would have to suck energy out of the air, lowering the ambient temperature, then store that energy in the weights by raising them. By the Known Laws of Physics, no such design for a grandfather clock can exist.

Let me stop you in your tracks before you rush to inform me that if we reverse time, and thus the velocities of the air molecules, the whole supercomplex "billiard-ball" system will start whacking the grandfather clock's ratchet in such a way that the surrounding air is cooled and the power weights begin to rise and the hands creep backwards. *Classical mechanics* can reverse entropy in this way but classical mechanics is the wrong tool with which to attack such a problem. Given a billiard-ball shot of this complexity, "nature" would have to measure its angles and velocities and momenta with an accuracy enormously greater than quantum mechanics allows.

Einstein notwithstanding, God shoots dice. God's Gambling House, being honest, always gives you exactly the same *odds* from day to day, but you'll never get the same event in response to the same input. A mathematician would say that "the initial conditions do not determine a unique solution."

Too many people make the mistake of assuming that all the physical probabilities either have to be "zero" or "one" before we can have a useful causality. But physicists have long been comfortable with error-bars; errors of measurement have never stopped them from making useful predictions. Why should we expect God to record his data down to an infinite number of decimal places? I suspect that even God cannot remember the number of hairs that once grew in Julius Caesar's left armpit or the details of the death of a London sparrow in the summer of 1832.

Consider a radium clock that tells time by counting alpha particles. Reverse the time flow. Classical mechanics tells us that the radium remaining at the moment of reversal

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will cease to be radioactive (since a radium atom which has not yet decayed cannot decay if it is only retracing its past). Classical mechanics tells us that the dispersed radon gas will magically return to its point of origin in the radium crystal just in time to capture an opportune alpha particle of the right energy to convert it into radium. Quantum mechanics predicts a different story. *Even under time-reversal* it insists that the radium must continue to decay into radon by alpha emission.

What kind of nonsense is this? Am I daring to say that if we backtrack through time, our footsteps won't fall into the same tracks? Absurd, Mr. Kingsbury—such rude behavior would imply that our Universe has a history of alternate pasts! But that is exactly what I am saying. The past that we remember is not the only past *that* we have.

Common sense—as well as the physics establishment, 19[illegible]—tells us that the Universe has only one past. (If you believe this, I can probably convince you that an electron is a particle.) Follow me in a bit of simple Aristotelian logic:

(1) Quantum mechanics tells us that the Tree-of-Now branches up into *alternate* futures—see Wheeler *and* Everett.

(2) The equations of quantum mechanics, for example Dirac, circa 1929, are time symmetric.

(3) *Therefore* the Tree-of-Now *must* root down to alternate pasts.

Contrary to everything you have ever been told, there is no entropic arrow of time. Entropy turns out to be Janus-faced, peering both into the future and into the past. We find a second arrowhead where we were told that the feathers would be.

You can't go back in time and kill your youthful grandfather because you wouldn't be able to find your grandfather among the plethora of alternate pasts. It is even worse than that. To locate your grandfather, a time machine must be able to effect a *decrease* in entropy. Because events are all entropically "downhill" from your grandfather to you, to get from you to your young grandfather is an "uphill trek" involving an increase in orderliness—a *decrease* in entropy. Discouraging.

It gets worse. Not only do you have to reverse entropy to reach your grandfather but there are zillions of "uphill" alternate pasts for you to choose from, only a microscopic few of them leading to your grandfather.

And all of the *easy* paths into your past, the ones that don't involve violating the laws of thermodynamics, the vast-vast majority of your alternate pasts, lie "downhill" in a direction directly away from your grandfather. Read your family letters and sigh. Stare at those old Kodaks and weep. Entropy forever bars you from those worlds just as effectively as it bars you from enjoying the fruits of a perpetual motion machine.

But what a concept! A universe of alternate pasts sounds like a great idea for a science fiction story. In Larry Niven's *Flight of the Horse* a time machine visits the "past" and brings back a unicorn. Unfortunately, it wouldn't be that interesting. Atlan-

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tis? Mu? Fairyland? Most of your alternate pasts wouldn't amuse you at all.

Do you commute to work along the New Jersey Turnpike? Imagine 10,000 cars, moving at 110 kph, tailgating each other and weaving across lanes at 8:45 A.M., all in a desperate hurry to get to Manhattan. You are one of them. Someone throws the switch on his time machine control panel. Time reverses. You are suddenly racing backwards down the New Jersey Turnpike at rush hour with 10,000 other cars hightailing it back toward breakfast, facing the wrong way.

Will you soon be regurgitating your coffee into a cup, and watching it convert itself into clear boiling water and coffee beans as you get sleepier and stagger backwards toward bed? Not at all! A fraction of a second after time does its flip, you (with your heart in your mouth) will be trying to remember which way to turn the steering wheel to stay in control. Sadly, entropy isn't going to be nice to you. Listen to the mayhem of a 10,000 car crackup!

In one of your alternate pasts, you weren't born of your mother; you were assembled out of blood and guts and splintered bone, put at the wheel of an unwrinkling steel car and sent off to work in New York's publishing industry. Given a time machine, you are much more likely to find such a broken past in a ditch than to meet your grandfather.

Preposterous? Am I pulling your leg? Let us retreat to the physics lab. We've been shooting electrons, one at a time, through a double slit and charting their impact. The hits form a diffraction pattern characteristic of waves. But we've been firing the electrons off one at a time and they have been hitting one at a time, just as if the electrons were particles. How can one electron pass through both slits? But if we run the quantum equations backwards, we see that the electron had many alternate pasts. In some of them it passed through slit one; in the others it passed through slit two. Simple. Recall that no physicist ever promised you that quantum mechanics was going to provide you with palatable answers.

When Erwin Schrödinger published his wave equation in 1926, it was in the form we call the retarded solution which tells us what we can expect to happen as time is increasing. Dirac very soon afterwards derived the full time-symmetric form of the Schrödinger wave equation which gives both retarded and advanced solutions for the wave equation. The advanced solutions describe what we can deduce about the past.

It is important to note that both Newtonian and quantum mechanics are time-symmetric. This means that you can be shifted from a universe in which time is increasing to one in which time is decreasing and you will not be able to detect any changes in the rules of physics.* Planets still orbit in ellipses. Water still freezes and boils. Vibrating electrons still emit

*(To be on the safe side we might have to pass you through a looking glass and switch your electric charges, too, but I don't want to go into that.)

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electromagnetic radiation. Does this "sameness" make sense? If time is reversed won't we be seeing things like scrambled eggs decooking in the skillet and popping back into their eggshells while swimsuited beauties are being ejected upward from the swimming pool to land spectacularly on the high diving board?

No. Time is a tree, not a linear sequence of movie frames. We wouldn't see such oddities as Humpty-Dumpty reassembling himself for the very same reason we don't see entropy decreasing (and broken eggs reassembling themselves) as time runs *forward*. Mechanics tell us that it is possible, but not very probable, for entropy to decrease as we move into the future. Because of symmetry, mechanics tells us that it is possible, but not very probable, for entropy to decrease as we run backwards into one of our alternate pasts. It does not even help to finagle the initial conditions; quantum mechanics will not guarantee us the same outcome for the same initial state, either backwards or forwards.

Did the Universe start with the Big Bang? Which Big Bang?

THE MEMORY OF THE UNIVERSE— DOES GOD HAVE ALZHEIMER'S?

A universe must have memory if it is ever to support any kind of time travel. There has to be a past or a future to go to.

Does our seemingly mindless Universe have any memory at all?

We know that *some* kind of minimal memory must be present because causality requires it. Using causality we can read from our sky vague memories of a "big bang" some 16±6 billion years ago. On the Moon enough fossil information survives to tell us about events four billion years ago. Hints of bacterial life on Earth three billion years old exist in stone that was once mud.

At low resolution, with pixels the size of planets, causality can tell you the structure of the Solar System for thousands, even millions of years into the past or future. At high resolution, with pixels the size of atoms, causality has a very short range view of the past, but memory is there and experimental nuclear physicists and chemists know how to exploit that short glimpse into time's fog. At super high resolutions, with pixels the size of the Planck length, causality doesn't seem to be able to recover much of anything.

Our own wetware memories would be useless if there were no analogs of them in the real world. Predictions of the future depend upon our memories of the past. Every day we stay alive by means of our predictions—for instance, we jump out of the way of buses before they hit us. The weather bureau can predict the weather up to a week ahead with reasonable accuracy and the President of the United States can predict the economy reasonably well for the next three days, and both can tell you that the Sun will rise tomorrow.

Acid rain is a memory of the coal-generated electricity we sucked from those plugs along the baseboards of our houses. The dry fields of the Texas Panhandle are a memory trace

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of water taken from a deep aquifer. The TV you watch is a memory of the time young Farnsworth was plowing the field and saw plowing as a way to paint pictures on a screen. You are a memory of a time when your parents were in each other's arms.

But all of these ephemera are only *partial* memories. They are fossils. They can tell you the shape of the bones but not the howls of distress. Information has been lost.

If we were able to roam through the past (or future), there would have to exist somewhere in the structure of the Universe a *perfect* memory of all past (and future) events. Imagine trying to go back to Rome and finding that Rome had been forgotten? Or overwritten? Or half forgotten so that Romans sometimes didn't have mothers or faces, or stuttered over their Latin declensions? Suppose the DNA in the Italian microbes lacked cytosine and the stinks in the street were wrong?

The universal memory state we need is a very strict condition. Any universe which permits time machines can be allowed to forget *nothing*. Abbreviations, loss of resolution, image compression, memory condensation—none of this is allowable. If the universe forgets, even has minor lapses like disremembering a telephone number, then time travel becomes impossible. Try going back in time and killing your grandfather in a universe that has forgotten things like the color of your grandfather's tie or how many eyes he has.

Does our Universe have a perfect memory? Physicists certainly used to think so. Most of them still do.

Under the roof of differential geometry we have classified mechanics, classical electromagnetism, and General Relativity, even Schrödinger's wave equation. All of these theories are executed, with calculus, on a stage called a differentiable manifold. Differentiable manifolds have very nice properties which I have no intention of explaining here. (Just think of such a manifold as a "rubbery" set of points which have not been assigned a measure for the distance between two points. Once we assign to our manifold such a measure, called a metric, we get a space—Euclidian if our metric is Pythagorean, non-Euclidian if our metric bends "straight" lines.)

These methods do indeed provide us with the tools to describe a universe-wide, perfect memory. The storage device for this staggering information capacity is a set of real numbers called "initial conditions" by the priests of differential geometry. (For the non-initiate just think of a real number as a non-terminating decimal. No matter how many integers are placed after the decimal point, there are always more.) An infinite amount of information can be stored in each real number. Indeed, if all the books and junk mail and grocery lists ever written by human hand were transcribed onto one real number we would still have room for, say, things like a list of unique nicknames for every atom in the known Universe, etc.

The machinery of Newtonian mechanics and general relativity store

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"the memory of the universe" in such "initial conditions." Take, as an example, a very simple universe of one particle of mass m, located at a position x and moving with a velocity v. Then m, x, and v are the initial conditions of the particle. Given a system of mechanics, we could then use these initial conditions to find the past and future behavior of the particle.

Simulating our *physical* space upon the framework of a mathematical manifold, plus metric, simplifies life for physicists appreciably taller than 10^{-33} centimeters, the Planck length. But—as convenient as the concept is—do not make the mistake of assuming that space *is* a metricized manifold. Such a construction is only a model and models break down. When we try to insert things like "epsilons that can be assigned *any* magnitude greater than zero" and "a minimum Planck length" in the same model we are in deep trouble. We are mixing apples and oranges.

With that caveat aside, let me say that many physicists still believe in a "universal memory"—mainly because it is a property of their most powerful tool, differential geometry. After merciless years in graduate school, studying bleary-eyed for their prelims, they no longer know how to think about space as anything else.

For instance, there is a whole group of present day physicists who are disturbed by the fact that black holes seem to swallow and destroy information about the past. These souls want to be able to run their equations of motion backwards and have the books that have fallen into the black hole pop out again, whole and legible. They cannot tolerate the idea of a whole slew of alternate pasts popping out instead in a kind of Hawking cornucopia. My only suggestion is that they study communication theory, and look at the Universe, not in terms of differentiable manifolds, but as a place in which the past communicates with the future via a "lossy" transmission. Information about the past is continually being lost. Physicists already understand the concept and call it "entropy."

How did such a crazy idea as "universal memory" become part of science? Nobody invented the concept; it just grew like some orphaned prodigy. The mother was a headstrong Newtonian mechanics and the differential equations which served her. The unknown father was probably religious conviction—"a universe that remembers everything" is comfortably similar to an all-knowing, all-seeing God.

Let me go back to the eighteenth-century, which is when the trouble began, and quote from Pierre Simon Laplace's *Theorie Analytique Des Probabilities*. A master Newtonian mechanic, Laplace was profoundly influenced by the power of Newtonian law. Accurate astronomical predictions could be made far into the distant future and far into the past. (We can accurately date ancient Chinese documents by knowing that they were written during a particular eclipse.)

In a moment of effusion Laplace tells us this: "Given for one instant an

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intelligence which could comprehend all the forces by which nature is animated and the respective positions of the beings which compose it . . . nothing would be uncertain, and the future as the past would be present to its eyes."

In modern terms he is saying that given the laws of mechanics and a sufficiently powerful computer, plus boundary conditions at a time t = o which consist of all the positions, momenta, and forces of the Universe, any event from the past or future can be computed to any level of desired accuracy. This is another way of stating that "the now" contains a total memory of the past and the future.

Why was Laplace's confidence so sweeping?

The classical physicists came to believe in a universal total memory because every law of physics that they used was time-symmetric and *uniquely* solvable. The *mathematics* which is at the foundation of geometry attaches to the Universe a "fast forward" button and a "fast rewind" button. No matter how many times one runs the Universe backwards or forwards, the *same* events flash by.

During the heady eighteenth-century days of mathematical breakthroughs, the dogma of scientific determinism was founded. The present fixes the past and the future.

A hundred years after Laplace, rational determinism was all the rage. Everyone was jumping on the bandwagon. Marxism was a deterministic theory of history based on a causal mechanics. He spoke of *social forces*, of *the masses*, of the *energy* of nations. Freudian psychoanalysis was a deterministic theory of the psyche. A young H. G. Wells built his time machine upon the deterministic foundation laid down by nineteenth-century science. The <t> for time was just another coordinate in the equations of the universe. <x, y, z, t> determined a *unique* event.

Such influence was long lasting—the early Asimov's psychohistory of the 1940s, in which Hari Seldon could make deterministic historical predictions over a period of a thousand years, via mathematics, was part of that philosophical wave. Unlike Marx, Asimov incorporated statistical mechanics analogies into his scheme.

There is no doubt that classical mechanics is deterministic. (1) Every dynamical situation is reversible and (2) has a unique solution. Since real numbers are used in the computations there are no errors. A computation can be carried indefinitely far into the future or the past without error. Mathematicians of the eighteenth- and nineteenth-centuries worked very hard to get this result. Basically they succeeded by overlaying their mathematics on top of a very smooth space that gives you no surprises no matter how small a region you chose.

In talking about "the universal memory" the classical physicist will offer only one reservation. When he mentions "singularities" it may be with the same terror that a computer aficionado feels about the accidental reformatting of his hard disk drive. The singularity, you will be told, is a

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memory wipe. You'll be warned not to zoom your time machine through the "big bang singularity." Therein lies amnesia—all information about any "prior" universe was wiped when, like toothpaste, we were squeezed out of the Original Point Source. There is nothing to go back to earlier than that.

This is a form of religious shop-talk. Singularities are merely the acne of differentiable geometry. Mathematicians, like teenagers, have this compulsive need to moan about their pimples while they poke around a pimple's edge. Such pathologies are an artifact of a geometry that can't digest things like Heisenberg uncertainty, not a property of the real space-time that you and I live in. Singularities cannot exist in a digital world which contains such things as the Planck length. Mathematical space and real space are not isomorphic. Physics has no more to say about singularities than dividing by zero has an answer.

The first cracks in the deterministic monolith did not appear until the late nineteenth century, at just about the time H. G. Wells was writing his time machine story. The challenge came out of thermodynamics. Carnot, Clausius, Kelvin, Gibbs, Boltzmann had been laying the foundations of the second law of thermodynamics, which puts the kibosh on perpetual motion machines and the like. Their work raised to a science the building of steam engines, internal combustion engines, turbines, refrigerators, atomic reactors, rockets.

Thermodynamics is not naturally deterministic—that was the rub. A time-symmetric deterministic system is mathematically equivalent to a system in which entropy is constant. Entropy, which is a measure of disorder, is related to the concept of information. The mathematics of entropy is identical to the mathematics of information theory. If a system's entropy is increasing it is losing information. So if you can show me a way of creating information without destroying more information than you create, I can use your method to build a perpetual motion machine.

We cannot proceed from order to disorder without losing information, without forgetting—and a time-symmetric determinism cannot forget. The early entropists finagled this point by the ad hoc addition of a device which unnaturally destroyed information. They set up boxes in phase-space in which they collected samples. The statistical operations done on those samples made information disappear—and out popped entropy.

At the end of the last century Ludwig Boltzmann was doing marvelous work to establish the second law of thermodynamics on a firm theoretical foundation and became involved in an endless round of acrimonious assaults. Zermelo and Loschmidt, among others, scorned him for his efforts, claiming that you cannot derive a time asymmetric law from a set of time-symmetric laws. Boltzmann acquired formidable enemies, including such luminaries as Mach and Ostwald.

He was so shaken by these attacks

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that he spent much effort and thought on the conundrum outlined above, making a stunningly valiant attempt to derive entropy from first Newtonian principles. He tried to create a universe in which entropy increased when time was reversed but was ultimately not successful. It can't be done for *the same reason* you can't get entropy to increase in a Newtonian universe in which time runs *forward!* (Cheating with phase-space boxes not allowed.)

Only with the work of Heisenberg and Schrödinger (after Boltzmann's death) did physics acquire a non-deterministic mechanics in which information about the future and past is lost in a time-symmetric way that puts thermodynamics on a first principle foundation. Physics has still not fully assimilated the message. Physicists still talk of time's arrow. When the great Wheeler and his student Everett proposed the many-worlds interpretation of quantum mechanics as an alternative to the Copenhagen school, they threw away the advanced (backwards) solutions of Schrödinger's equation as "meaningless." Dozens of physicists have proposed "hidden" variable riders to quantum mechanics in an attempt to preserve a Newtonian-like determinism. Etcetera.

But the message is clear. Time travelers beware. God—or Laplace's computer if you prefer—has a very hazy vision of the future and just as hazy a vision of the past. God does not calculate with a mathematician's real numbers. Everything He does is subject to round-off error. Your time machine will have to do a lot of ad-libbing and Hollywood-like set building in the no-man's land between God's error bars.

TIME MACHINES

Model 1: We build a sphere. By means of Clarkean magic we reverse time inside at the rate of ten years per day. Our time traveler crawls into the machine on March 31, 2001, and spends ten subjective years inside before he climbs out. When he does, he is not ten years younger than when he went in. Entropy, again. He is ten years older. He buys a newspaper and finds out that the date is April 1, 2001. His time machine is the *equivalent* of a machine which ages a man at the rate of ten years per day.

Model 2: This is a new design. It is obvious from the results of Model 1 that we will have to use our Clarkean magic on the *exterior* of our sphere, thus rewinding the whole Universe for a new start. We try it. When we open the hatch there are no dinosaurs. It is a bit of a mess, though. Our reverse time field only expanded at the velocity of light. There were problems at the boundary where reversed time met normal time. Nothing that time won't heal. Just major tectonic collisions. What's a planet or two? Given a few billion years our expanding time-reversal field will have eaten the whole Universe and we'll be safely on our way to the Big Crunch.

Model 3: Disasters never stopped a dedicated science fiction writer. For our third attempt let's try a faster-than-light time machine. We all know

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the limerick, "There once was a lady named Bright/who traveled much faster than light. /She departed one day in a relative way/and came home the previous night."

To make it simple let us send Miss Bright off in her ftl yacht at 1.4 light speeds for a day of fun. By the Einsteinian equations this is just enough to reverse her time flow by one day per day. After a day of such fast living, is she a day younger? No. She is a day older because entropy *increases* whether you are going forwards or backwards in time. When she returns, does she come home for "the previous night"? No. In fact she finds that Earth's clocks have advanced by 24 hours. Why?

Here is what the physicists forgot to tell you about the mathematics of ftl though they learned it in the first course they took on relativity. *The clocks of the Universe are not linked synchronously.* Einstein called it the Principle of Non-simultaneity. The rate and direction of time flow are only *local* phenomena. Your starship clock may be running slow or even backwards, it may be doing the jig; nevertheless nothing requires Earth clocks to stay in lockstep. Your ftl ship may travel 30 million light years off into the galactic void, and then back to Earth, all at slightly above the velocity of light to keep ship's time both reversed and slow. The crew will hardly age during the journey, but when they get back to Earth they will not find dinosaurs, they will find an Earth 60 million years *older* than the one they left. The time-reversal was only local to the starship.

Remember the word "local." It is a time machine killer. There is no way to globally change the direction or pace of time. Recently there has been all sorts of talk about weird time machines that use rotating cylinders, massive rotating toruses, and zooming strings passing each other at near light speed. Mathematically we can follow a path through these weird worlds in which time is reversed. But all this is local to the inside of any time machine and it doesn't really matter what goes on *inside*—when the door of the time machine is flung open, we find neither baby grandfathers nor screeching dinosaurs. Time has been marching forward relentlessly for the rest of us. Relativity doesn't expect clocks to stay synchronized.

When I taught calculus to first year university students I loved to play dirty tricks on them like proving that 60 million B.C. was equal to 1994 A.D. Only about 1 in 40 students could catch the flaw in my reasoning—I very carefully neglected to remember an important "constant of integration." It *is* true that $-60{,}000{,}000 = 1994 + C$. Alas, physicists with Ph.Ds can forget their constants of integration, too. That's where some of their time machines come from.

In physics, when we deal with time, what is important is not the interval between dates, though that is what appears in our equations. More fundamental is a derivative of time, the rate at which time flows with respect to some standard reference frame. If we are moving at the velocity of light, that rate is zero. If we

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could move faster-than-light, that rate would have to be negative. If we move close to a massive body, the rate slows down. If we move away from a massive body, the rate speeds up. A clock is our mechanical integrator of time flow.

In Newton's time there was no need to notice the *flow* of time because it was thought to be constant regardless of the frame of reference. Two synchronized clocks stayed synchronized no matter what path they took through the Universe. Einstein showed us that it was not so easy. Time's flow varies with frame of reference. The date on a clock face is not independent of the path that the clock has traveled. We can speciously "create" all kinds of time machines by maneuvering our traveler through a complicated Einsteinian space-time warp and then—only at the end of the journey—reverting to Newtonian mechanics by assuming that the clocks of the Universe have been synchronized all along. You can't have it both ways. Local time-reversal does not equal global time-reversal.

Before you grin at the idea of having ftl travel liberated from time paradoxes, let me sober you up. If we travel at 1.4 lightspeeds the equations tell us that we age at the normal Earth rate. What if we build a machine that can traverse a thousand light-years every 3.65 days—that's a hundred thousand light-speeds. Then what? Let's send a ship to the Pleiades of Taurus, while we safely remain home. Our target is Pleione, a lovely B7 giant 400 light-years from Sol. Our ship comes back from its flyby after three Earth days—but the crew is 800 years older. They traveled 800 years backwards in time, the hard way, while we were moving forward in time at our usual leisurely pace. For faster-than-light travel Einstein's equations give us the reverse of the "twin-paradox."

This makes for interesting science-fiction stories. I used that theme in my story "Shipwright" which appeared in *Analog*, April 1978. The godship of *Courtship Rite*, *Analog* 1982, also operates under the same constraints. A faster-than-light starship will do some funny things with space-time. What it *won't* do is send you back into "the" past.

Model 4: Let's try something even more desperate than ftl. There has been talk of using wormholes as time machines—more as a stimulus to examining the boundaries of general relativity than as a serious proposition. The best description of such a machine is in Kip Thorne's book *Black Holes and Time Warps*. Again we'll use Clarkean magic to whump up such a wormhole.

Here is what Kip describes. The mouths of the wormhole are two spheres, each two meters in diameter. In normal space they can be as far apart as we care to move them, but through hyperspace they are connected by a tunnel that always remains thirty centimeters long. The tunnel is prevented from collapsing by the use of "exotic" matter which must have a negative energy density as experienced by a beam of light passing through it.

This is a great way to move across

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the light-years in the time it takes to crawl across thirty centimeters. Kip suggests that the device may also be a time machine and Robert Forward built his novel *Timemaster* around that concept. Kip operates the wormhole time machine like this:

One mouth of the worm is put in a spaceship with its pilot. The other mouth stays on Earth with an assistant. The pilot and her assistant hold hands through the wormhole. Our spaceship departs at nearly the speed of light for a twelve hour journey by ship time, a ten year journey by Earth time. After twelve hours the pilot releases the hand of her grounded assistant. The pilot is by then already back on Earth, but her assistant must wait another ten years for the spaceship to return. This suggests that the two mouths of the wormhole are now separated by a few meters of space but ten years of time. Messages from the newly returned pilot can now be sent back through time via the wormhole.

What is wrong here? In his comments Hawking suggested that a beam of vacuum fluctuations might shut down the wormhole before it became a time machine. I see a more fundamental flaw. A wormhole is clearly a general relativistic machine involving, as it does, some very curved space. Thus it must obey general relativity's prime law; the equivalence principle—which states that locally we cannot distinguish between inertial acceleration and gravity.

The pilot will be feeling acceleration as her starship accelerates. She is holding the hand of her assistant who, by remaining on Earth, is not accelerating but who must nevertheless feel the acceleration in his arm which will appear as gravity to him. General relativity demands that if one mouth of a wormhole is inertially accelerating then a gravitic field *must* be induced inside the wormhole tunnel. It won't collapse until the two wormholes are brought to rest.

When the ship stops accelerating, the Earthbound assistant will see through the wormhole tunnel a redshifted pilot. (We won't mention his arm, which will be reaching through a humongous field, or the time variation across his arm.) The redshift is the consequence of looking down into a very deep gravity well. With this redshift is associated a substantial slowing of time. In fact the time slowdown will be so great that it will take the pilot ten years to let go of her assistant's hand back on Earth. She will think it only took her twelve hours. He will be exhausted. Even if Clarkean magic *can* keep a wormhole stable, there is no way that you can make a time machine out of it because of that redshift.

This is the "static" case. The fun comes when you try to move through the wormhole. Nobody has done adequate work on this. Don't expect your intuition about oil pipelines to work here. An essential element of wormhole construction is the lining of exotic negative energy-mass. Push on negative mass and it accelerates toward you, as if the force were operating backwards in time. And negative mass does not slow time, it speeds it up.

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The physics looks a bit like *Alice Through The Looking Glass*. Expect weird phenomena. When you try to shove something through an end-accelerated wormhole you may find yourself generating a gravitic "back-EMF" that converts kinetic energy into negative mass. A wormhole between here and Pleione may be 30 centimeters long spacewise, but how long is it timewise—400 years? I may be able to crawl through and back again in ten Earth seconds by the clock at the Terran starbase, but will I be 800 years older by the time I get back?

I wait anxiously for some general relativity maestro to do the math for us! Whatever the details, the equivalence principle will not allow a wormhole time machine.

THE ONE AND ONLY NOW

One of my most vivid memories as a child was walking into a vast clock shop with thousands of timepieces from grandfather clocks to delicate watches, a cathedral resplendent with glass domes and torsion pendulums and crazy cuckoo clocks and every kind of ticking wonder. No two of them told the same time. I watched one grand mantle clock strike four, and later when I was marveling over another clock that was striking four, I glanced back at the first one to see if I could see myself at that earlier four P.M. It didn't happen. There is only one now, no matter what the clocks say—because of that sneaky constant of integration. I remember that I was indignant that the shopkeeper didn't keep his thousands of timepieces in lockstep. I reproached him. He had spectacles and a white beard. He only smiled down at me among his treasures and told me that he was an Einstein, not a Newton. I didn't know what he meant then, but I do now. ■

ABOUT THE AUTHOR

Donald Kingsbury received his mathematics degrees at McGill University in Montreal, and taught on the staff from 1956 until 1986 when he took early retirement to pursue his writing career. Several of his stories, including the novel *Courtship Rite*, have appeared in *Analog*.

FURTHER READINGS

If you like fantasy in your science, the Copenhagen interpretation of quantum mechanics has magic wizard observers. If Occam's razor is not one of your tools of choice, the Hugh Everett many-worlds interpretation or David Bohm's hidden variables may appeal to you. For conservatives, the Cramer transactional interpretation is both wizard and redundancy free, and brings the time symmetry of quantum mechanics into startling relief.

(continued on page 157)

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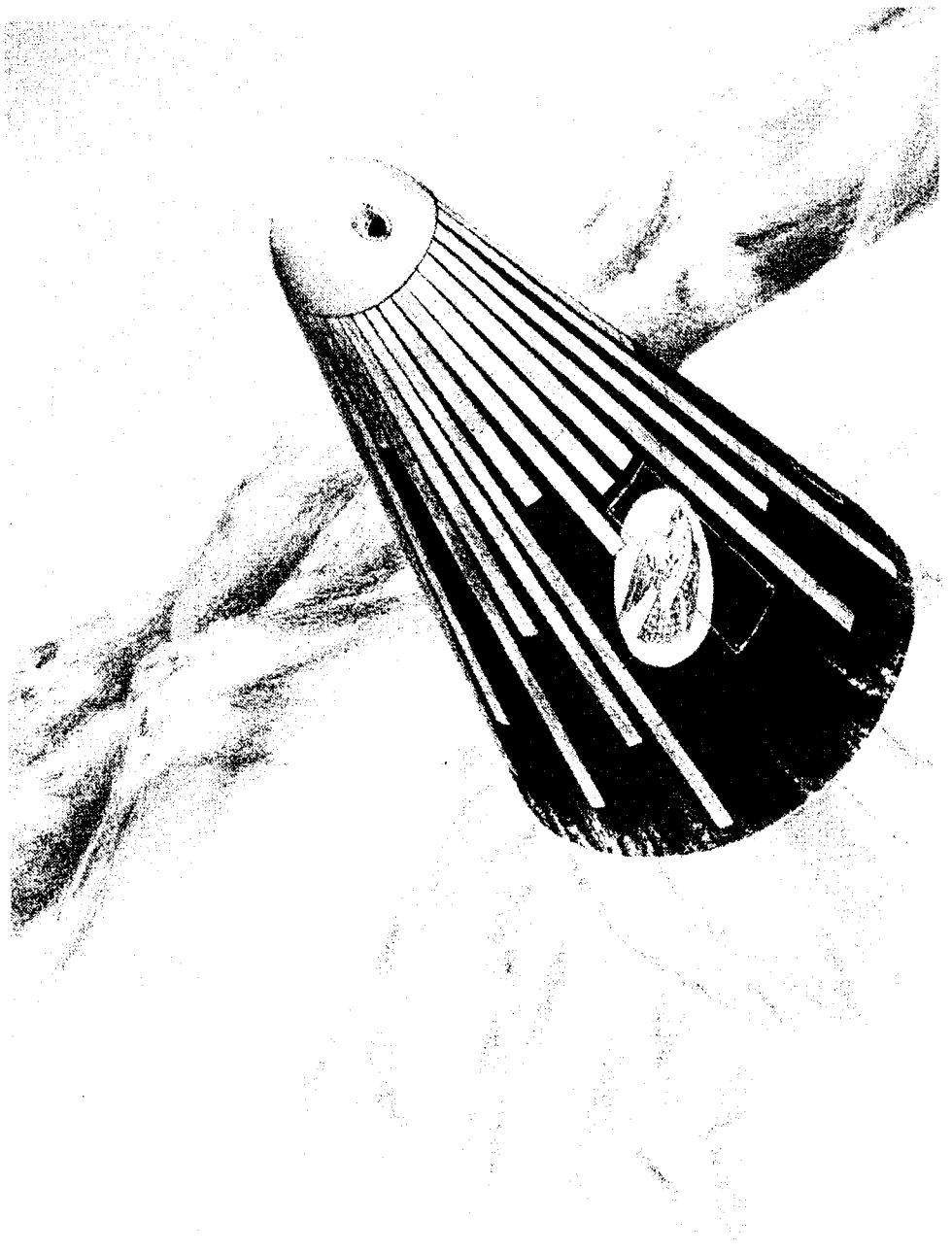

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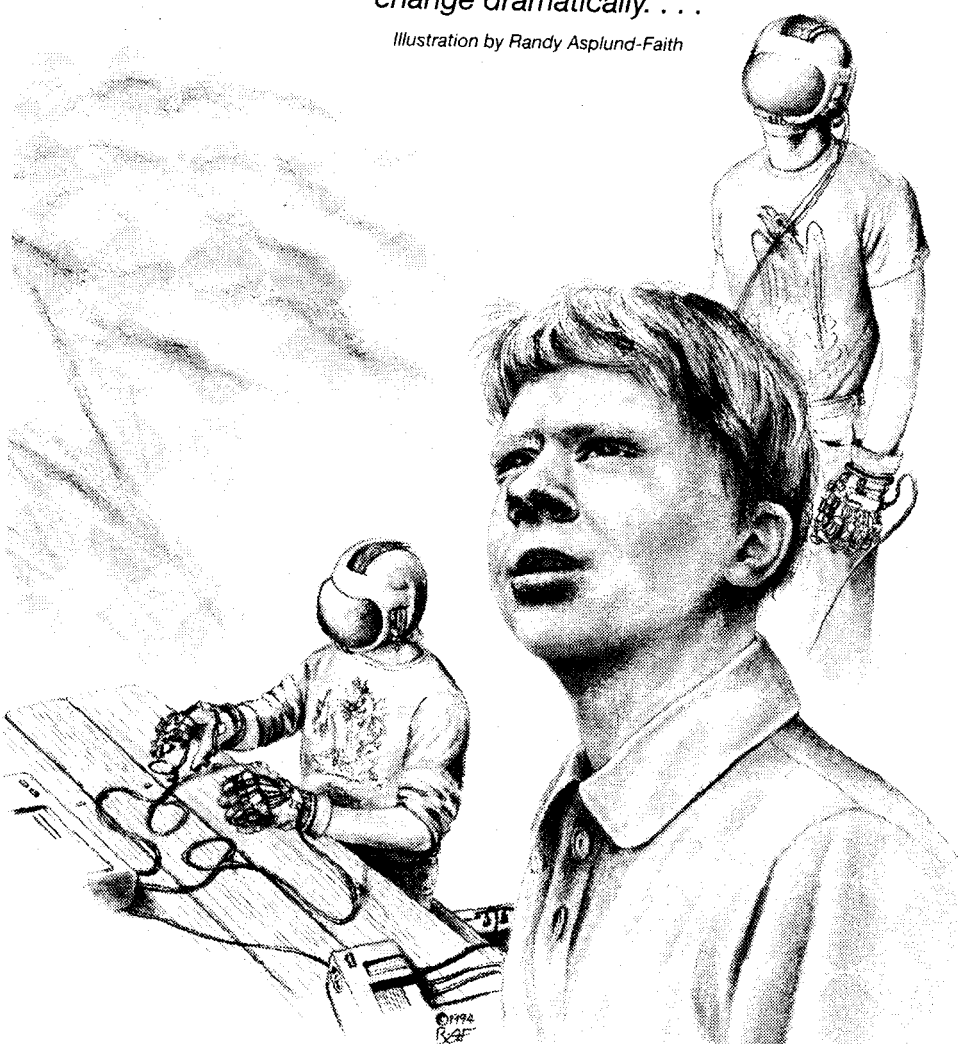
Mike Moscoe

TOUCH A STAR

What constitutes "child's play" can change dramatically. . . .

Illustration by Randy Asplund-Faith



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Dave pulled hard on the rope, driving the backyard swing up into the cool evening air. He held his breath, trying to catch the fleeting moment of weightlessness at the top of the arc. It was gone too soon; he began the plunge back. *Earth sucks.*

The swing thumped and bumped, swaying with his weight. It was for kids, not a thirteen-year-old. But he always came to the old swing when his world was flying—or when it crashed. He came because of a memory, or a memory of a memory.

"Mommy, David ride starship." Even at three he'd known what he wanted. He watched it every day on TV.

"No, David. You can't ride a spaceship."

At three he'd discovered can'ts; he'd found a lot more since. But at three he'd also started hunting for ways around can'ts. He pulled urgently on his mother's dress. "David ride airplane."

"Yes, honey, someday you and Mommy may ride an airplane."

He wasn't finished. "David touch a star."

For a moment, he thought he'd done something wrong; his mother just looked at him. Then she picked him up and held him so tight. He could still feel the wet tear on her cheek. She hadn't said anything, just brought him out to the swing.

That warm evening they had swung forever high. The stars seemed so close, just beyond his fingers. Yet even when she held him up, he could not touch the stars.

His pocket phone beeped, pulling David back to the present. He ignored it, pulled harder on the ropes, pushed himself higher. The swing threatened to tumble over but he didn't care. At the height of the curve, he threw himself into the air, clutching for a star. His fingers grasped air.

Landing with a drop and roll that would make any Starship Trooper proud, Dave felt the letter crumple in his pocket. As he jogged for the back door, he straightened the envelope. It was a real letter; in the fading light, he could see the stamp. The mailwoman had brought it on her weekly round. It said he would never touch a star.

In his bedroom, the monitor was flashing, CALL WAITING FROM TERRY. Dave's voice broke as he accepted the call.

The screen lit up, then split to show Terry and a construct of Joe. His folks didn't have a video on their phone.

Terry scowled at his open letter. "Sixteenth at 99.70. Close but no princess."

Joe's construct shrugged. "Nineteenth with a 99.68. What about you?"

Dave spread his letter out. Halfway down the page was what counted. It hadn't changed since the last time he looked.

Students tested	553
Your weighted average	99.72
Your class standing	14

Damn! What's the difference between tenth and fourteenth—.02, maybe .03. Maybe one more question right? Shit!

What's the difference between

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tenth and fourteenth? Several thousand dollars, Dave answered his own question. *The difference between the standard high school voucher and a full ride scholarship to Stephen Hawking High.*

"I missed too. Fourteenth."

"I guess we'll all be together at Bud Clark next year. Whoop, whoop." Joe's cynicism said what David couldn't.

"With all the jocks and rocks," he groaned. Nobody liked the kid who ruined the curve. The three of them had busted quite a few. *Maybe it was time to quit that.*

"Hey, cut the funeral," Terry snapped. "We ain't dead yet. The best science project in town gets a full ride. I say it belongs to us."

"Yeah, how?" Dave glumly shot back.

As usual, Joe was ready to toss out an idea. "Let's build a rocket, something with lots of boom and flame." Joe liked games that ended with explosions.

Dave scratched thoughtfully at all three bristles on his chin. "Two years ago a sounding rocket with an ultraviolet payload got the scholarship when it showed the ozone was healing above Portland. But last year the same project came in sixth."

Terry snorted. "Then we go straight for orbit. No middle school's ever put up a satellite."

"That's cause TWA don't take payloads below high school level," Joe cut in.

But Terry's grin just got bigger. "We build our own rocket. That ought to beat the shit out of any game boom."

Joe's simulation sprouted a grin like a drugger on a double load.

Dave tried for a reality check. "The school has a standard rocket that projects have to use, and it won't make orbit."

Joe made a rude sound. "The damn thing's ancient and way over weight. With the new Buckistring composite my dad uses on the stock and funny cars, we could do something that's out of this world." He was off the pad and climbing.

Dave couldn't believe his friends. "Aren't you guys listening? Nobody's going to let us put anything in orbit. They got traffic management up there just like on the Interstate. You bounce something off a Clipper and a lot of people are going to be pissed even if we don't hurt anyone."

Terry wasn't in listening mode. "So you check the schedule, Dave. You can get into the traffic net. We launch when you say it's clear. Crew, we go for the gold here or we forget Stephen Hawking High," Terry grimaced, "and the rest of our lives."

Dave leaned back. Terry was right about that one. They couldn't just be good, they had to be spectacular. But Terry had no idea of the risks he was tossing around. He also was forgetting one hell of a lot. "They don't give scholarships for rocket motors. What are we supposed to do in orbit?" That ought to stop him. It didn't.

"Find creation," Terry shot back. "*Popular Mechanics* is advertising this neat set of build-them-yourself infrared goggles that pinpoint where heat's getting out of your house. I say

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we ramp up that design, put it in orbit, and go hunting the Big Bang."

Dave worried his lips as he studied the advertising in a third window on his monitor. "It took a zillion dollars and a mob of scientists to build the Cosmic Background Explorer twenty years ago."

"Yeah," Terry agreed. "So, when a couple of kids do COBE cheap, they've got to give us some respect."

The doorbell rang. That would be the pizza Mom ordered for supper. Dave studied the schematic on the screen. He could do that! There were ways to shrink it and make it better. As long as they didn't kill anyone, why not gamble?

The doorbell rang long and insistent. This might be the last thing between him and that dorky uniform the pizza delivery man wore.

"OK," Dave said from his bedroom door, "let's do it."

Mom already had her hands full of pizza by the time Dave got to the front door. Dave winced; it was his job to lay out whatever food Mom ordered. She stayed at her desk until he phoned supper was ready. Dad came later. He never left the factory before Dave and Mom were half done with dinner, but Dave understood. You couldn't leave computer chips half baked.

Mom knew about the letter. Had she told Dad?

The pizza was still warm. Before Dave could take over his usual job, Mom started reslicing the pizza with an abandon that left David fearing for her fingers. "Izu in Japan and I are dealing over a shortage for, ah, a drug in India." Mom debriefed her day, leaving out what she thought a boy shouldn't hear. Dave knew she often dealt in contraceptives and other women stuff.

Mom glanced up. "I may have to go back to work after dinner. With the health insurance due this month, it would be nice to get a good commission." Her eyes fell back to the pizza. She always got embarrassed when she talked about money.

The clock over the fireplace chimed and a holo appeared on its face. A bear chased a hunter across the face of the clock, captured rifle jerkily hammering the man's cap flat with each chime. The bear got in six hits. Dad had seen the original somewhere and built the simulation as a present to Mom.

The last brassy note was dying when Dad surprised Dave by showing up on time for dinner. "Sorry I'm late. That smells good. How'd your day go at school?"

Dad said that every night. Dave wondered if this was a holo program, too. Then Dad reached over, punched his shoulder, and grabbed the two biggest slices. "Us growing boys got to share."

"Yeah, but I'm growing up. Some people are just growing."

That got Dave another punch, but Mom gave Dad one of those wide-eyed looks. She'd quit adding, "From the mouths of babes," after Dave told her he wasn't a baby.

Dave got one of the big slices back.

The first slice of pizza disappeared in a silence that drained it of taste.

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Dad paused, looked at his second piece and folded hands. "Mom tells me you did quite well on the entrance test to Stephen Hawking High."

Dave pulled out the letter, glad to get it out of his pocket. He forgot to wipe his fingers and pizza smeared the address. Dave hadn't handled many letters; everyone just sent e-mail. But the school board was old fashioned; test results came by U.S. mail.

Dad spread the letter under the dim light above the kitchen table. "Damn good," he beamed, but his smiled wavered around the edges; he knew. "Fourteenth out of five hundred, and only the best even try. That's something to be proud of."

"I know." Dave said the empty words, anything to fill the silence.

Mom stared at her plate as she patted pizza sauce from her lips. "I ran into Ms. Salvador in the e-mall last night. Her boy graduates from Hawking this year and is going into the Air Force. He's looking for someone to take over his paper route." She focused on Dave. "It supported his stipend all four years."

"Mom, we agreed. My job is school. I'm getting straight A's." *Almost. Gym didn't count.* "And besides, everybody gets their paper on line. Only the old folks at the retirement park need newspapers. They're too dumb to use a computer."

"Now, honey, I know it would mean less time for your games, but you could—"

"Lisa," Dad cut Mom off, "enough." Their eyes locked for a long moment. At the same instant, Mom's gaze fell to her plate as Dad pushed back from the table. He stood, back to them, eyes staring at something beyond the picture window, his scowl reflected back by the black night. *Was Dad that mad at him?*

When Dad finally spoke, it was to his reflection. "I started saving for college the day you were born. Seven years back, I could tell the damn voucher wouldn't cover a good high school. When the levies kept getting voted down, some politician was bound to let schools opt out and charge extra." He clenched his fist. "I saw it coming."

Dad turned back to the table. "I thought I'd be ready when you needed money for school, but the next generation of chips came out a year early. I had to retool just to stay in business. It took everything we had. I was sure we could make it back, right up until the recession hit. Now I'm bidding contracts at cost." Dad slumped back into his chair.

Dave said nothing. He'd sat through the VR's in civics class, telling about the wonders and freedom the information revolution brought to the American worker. Dave aced the test, but there was nothing on them about Dad scrounging for contracts or Mom scrimping to pay the health insurance. Around the house, the right answers felt wrong.

Dad picked up a fork. "Damn it, we've got two people working their butts off to make ends meet. It ought to be enough."

Dave couldn't just sit there. "It's OK, Dad, Terry, me and Joe figure the

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science project scholarships belong to us."

That got Dad's attention. "What do you have in mind, son?"

Dave had never lied to his Dad. Carefully, he explained Terry's idea without quite telling an untruth. Dad wasn't nearly as thrilled as he expected.

"Dave, I was your age when Cosmic Background Explorer hit the news. I hate to say it but Terry might not have such a good idea."

"Huh." Dave had expected Dad to be excited, especially since he hadn't told him the half of it. A chill ran through him, turning the pizza to acid. Did every grown-up have to put down kids?

"Son, it's been a long time since I read anything on how they found the leftovers from the Big Bang, but, if memory serves, you'll need cryogenic cooling."

Relief swept Dave. Dad wasn't against him; he was just problem solving. That was fun. "The glasses don't need any."

"Right," Dad nodded, "but when you're hunting for something only two or three degrees above absolute zero, you need cold sensors. You might want to check it out; I could be wrong."

Dave could count on one hand the number of times Dad had been wrong. He was just trying to go easy on Dave. Terry hadn't mentioned just how cold the cosmic background was—and Dave hadn't asked.

"I better do some more homework. May I be excused, Mom?" Polite words like those Dave usually kept between himself and grandmother. Tonight he needed them at home.

Mom smiled through a worried shadow. "Yes, son."

"Dave, if there's anything I can do to help with your project. . . ."

Dave groped for the words his Dad needed to hear, but the whirling inside his own head could only give up a "Thanks," that seemed worse than nothing. He left the letter on the table as he fled down the hall.

Back in his own, a window on the monitor was flashing, announcing the analysis he'd been running of "Ultimate XXI" was finished. Dave had the program cold this time. He was going to save the six princesses, capture all the gold and kill the dragon—while beating the official best time. He'd run the paths of each of his adventures through the labyrinth one last time. No one had yet been able to beat ten waits, but Dave was sure he could. The program was ready to run, inviting him.

Dave closed down the window; he had a project to build. It took him ten minutes on net to find out that Terry had once again come up with a great idea—that couldn't be done. Dave spent the next hour doing what he did best, figuring out how to make it happen.

Dave met his friends next morning at their usual place under the tree outside school. Terry handed him a full project plan; he'd used his Dad's project management software. It was a beautiful plan—and all wrong. Dave tore it in two.

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Terry grabbed for it. "What's the matter with you, you on something?"

"Infrared *astronomy* ain't anything like heat management. We're not looking for 60 degree air seeping out of a house. We've got to find the difference between 3 degrees Kelvin and 2.99999 to the zillion degrees. We'd have to use cryogenics."

Terry didn't back down. He never did. "No we won't."

"Want to bet?" Dave cut him off. He waved three hard copies he'd taken off the net. Two minutes later, even Terry could see they had a problem.

Joe took the two pieces of Terry's project plan and wadded them up. "Now what do we do?"

Terry kicked the tree. "But I told Mr. Montgomery we'd turn in a science project plan today."

"Tell him your Dad's printer went down and you'll have it tomorrow." It was neat how two heads swiveled around to lock on him. "There were three sensors on COBE. Two required cryogenics. We do the third." Dave pulled a report on the Differential Microwave Radiometer from his backpack and handed it to his friends. They were still studying it when the bell rang.

"We can do this," Joe said slowly.

"I can redo the project plan tonight. We'll be all set for tomorrow," Terry crowed.

After school the next day, while briefing Mr. Montgomery, they found out how far from set they were.

Their science teacher stared at the design plots the three had done. This was the "official" version; the real one wasn't done yet. They'd keep that one to themselves until after their satellite was up. Then they'd sell it to *Newsweek* or *People*.

Mr. Montgomery eyed them. Dave knew how the butterflies felt, pinned to boards in the ecology class. "Why not use a balloon or model airplane?" The teacher asked.

"The microwaves we're after are absorbed by the atmosphere," Terry jumped on that one. "We have to get above 30,000 feet. We couldn't find a design for a model airplane that went that high." Terry glanced at Dave, dumping the hot potato on him.

"A free floating balloon could do the job, but the winds aloft this month would blow it halfway across the country. None of us have driver's licenses yet. Would you chase it for us?" Dave put his "kid begging" face on, all the time praying *Say no. Please say no.*

"Sorry boys, that's not the way I want to spend my weekends." The teacher went back to studying the plan, and Dave started breathing again. "You're using a lot of reaction mass."

"Yes, sir," Terry swung at this one. "The normal rocket just shoots up and parachutes down. We want ours to be more like a Delta Clipper. We'll throttle the fuel flow back and let it climb slower between 30,000 and 100,000 feet, hover a while and bring it back down on its rockets until it runs empty. That way we can get more readings, and more accurate ones. Dave's got a public domain game version of the DC-3's flight

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software."

Dave tried to smile the way adults liked kids to smile. This rocket was going like an Icer for his dealer the moment it took off. Dave would touch a star. But Mr. Montgomery couldn't know that, not right now. "It's a cool game, and we'll test the rocket and the software before we launch. We have to test the engines anyway."

"Yes." The teacher frowned at the blueprints. "You're replacing the rocket's motor with four smaller ones."

Dave again took the lead, careful to keep his face straight and his voice level. "Yes, sir. That's Joe's idea. His Dad is using some pretty heavy-duty Buckiposites in his race cars. Joe thinks he can make a motor that will take much higher pressures and temperature. That's how we'll double the height of this experiment, to nearly twenty miles." *And then some.*

"Will the rocket casing stand the strain?"

"Yes, sir." Dave dove on. If his mother knew he could lie like this with a straight face, she'd ground him 'til they balanced the federal budget. "Joe thinks the casing is way overdesigned. It will take the stress. Just in case, we'll set up the launch crew farther back from the rocket."

"How much fuel will you need? If it's too much I'll have to fill out the anti-terrorist paperwork."

"We'll get our own fuel." Terry jumped in—too quickly Dave saw. Mr. Montgomery was giving the boys one of those adult stares like he could read the fine print on their souls.

Dave tried to cover. "My Dad buys hydrogen peroxide by the 55-gallon drum to clean chips. We can get kerosene at any camping store. Since we've got to test the motor a few times, we'll need extra. We don't want to tie you up." Dave put that smile on, but not too much of it. Mr. Montgomery *had* to buy this part of the project.

They'd never get to orbit with the wimpy stuff the school used. But some of the funny cars Joe's dad worked with used real jet fuel, and the boys had spent an hour working out how to distill and freeze the regular 50 percent hydrogen peroxide until they had 93 percent concentration. That would give them the bang they needed.

Mr. Montgomery nodded. "Anything that cuts down on the paperwork makes my day." He stared at the ceiling for a long minute, then went on. "Get me a note from your folks on the fuel. Now, if you boys are going to maneuver this rocket, you'll need to gimbal Joe's new motors. The test bed for the original DC-X used the U-joints off an '87 Ford Econoline. Joe, your dad ought to be able to get you some good stuff."

Joe led the boys in a round of head nodding.

Mr. Montgomery tapped his pencil on the drawings, staring through the three of them one last time. He tossed down the pencil. "Why don't you boys build your own rocket casing from scratch? You can still have the fuel pump and parachute from the school rocket, but all the changes you have in mind would really mess it up

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for the next class. Keep me informed."

Biting his lips to hold in his grin, Dave thanked Mr. Montgomery. They wouldn't have to break up the old rocket! Every idea they'd come up with so far looked darn suspicious.

The briefing over, the three left the school yard as fast as they could walk. They didn't start celebrating until they turned the corner and the school was out of sight.

Dave had four weeks to do what an army of engineers and scientists took seven years to do, but he had an advantage—Dad and the latest development software and production equipment.

Dave knocked on the door of the factory and Dad let him in. The windows were barred against burglars; the garage was warm with the smell of burnt plastics and resin. Dad fixed things: computers, TVs, recorders, anything that had electrons and chips. He also manufactured replacement parts for airlines, cars and was a subcontractor for the area's rapid transit. From the kilns and etchers here, he could make any component they gave him the CAD drawings for. Better yet, Dad could modify the old stuff, incorporating the latest advances in chips. Dave had been excited the couple of times he got to help Dad, but today was different.

Dad offered him a chair, just like he was a team member.

Dave tried not to fidget while Dad marked up the project outline of half truths and downright lies. *Should I tell him?* Dave glanced around at the factory's production tooling; Dad hadn't asked Dave when he poured his education money into the last upgrade. Grown-ups didn't have to tell kids anything. Why should kids? This answer didn't feel right, but it was one he could live with—for now.

Dad put down the outline. "I know a few distributors who'll donate some off-the-shelf stuff for you."

Dave nodded thanks as Dad turned to his computer. "Charley, let's close all the windows and disable voice input." Dad's computer screen went blue. "With us talking, I don't want to confuse Charlie. Besides, I need practice keyboarding."

Dad didn't look out of practice. His mouse flew over the screen as he showed how the software would design Dave's chips, debug it and run simulations on it. "It will turn it over to the factory then, but make sure you've got it right. Silicon isn't cheap." But Dad was grinning as he said it.

Dave looked slowly from one piece of equipment to the next, taking them in, seeing them differently this time. A circuit of the garage finished, he returned to his Dad. "The program does all the work." *You're just a button pusher! My education money is making us all into something that just turns on a machine!*

"Not really." Dad's confident, grown-up-in-charge-here smile never wavered. "It's like the analysis you run on your computer games. To save the princess, everyone has to be where you want them, when you want them, and not waste any time getting there. View each computer

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instruction as one of your adventurers. Now, is there only one way to save the princess?"

Dave shook his head. He understood games—or did he?

Dad cocked an eyebrow at him. "Right. There are many paths, and every time you optimize one adventurer, another one slows down." Dad never wasted time on games, but he sure seemed to understand them. Dave glanced down, his eyes hunting for any place to look except Dad or machinery.

Dad got him his first games. Dad always asked him about his new games, just like he asked about school. Sometimes Dad seemed more interested in the games than school. Dave saw why now. The games weren't for play. They were training vids, just like the ones at school. Dave's breath exploded from him. *Hope someone did a better reality check on them than they did on some of the school vids. I guess I'm about to find out.*

So the adult world had been playing games with the kids. *Let's see what happens when kids play back.*

Dave looked up and his Dad went on. "What you do, son, is keep looking for the best overall compromise."

Dave saw the connection. *Boy, do I.* "Right," he told his father.

"And you're the one who decides what it is. The ten-dollar word for it is iterative design, but you've been doing it for years. I'll give you access to my system from your bedroom computer. Have fun, son."

Dave headed for his room. Dad had a weird idea of fun. Then, all grown-ups seemed to have strange ideas. Dave wondered how they got that way, but he didn't have time to waste on that. He had compromises to make.

Dave halted at his door. *Compromises. Was it the compromises that made adults what they were?* Touch a star. David, touch a star. *Hold on to that. No compromise there.*

But before Dave could compromise anything, he had to design the pieces he was fitting together. At the center of everything was the microwave radiometer. Dave found a copy of the thirty-year-old design on net. He stared at the huge thing for two long minutes, wondering how he'd ever fit it into his tiny payload. The sensors generated its own microwave signal, mixed it with the weak cosmic background, then boosted both to a level that could be measured. For a second, the original design grabbed him, held him like a drowning elephant and threatened to pull him under.

Then Dave broke free. "This's just like the booster in my pocket phone. Different wavelength, but the same idea." Dave leapt from his chair and danced around his desk. The signals from the com satellites 150 miles up were regenerated billions of times a day. "Hell, I can get a dozen of those chips at Radio Shack for a dollar." *The grown-ups who put this together weren't so smart!*

Dave quit his dance, remembering his trip to the science museum. They'd shown him a vacuum tube as big as his fist. Now, a square inch chip

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had billions of gates better than that tube. Those old folks didn't have anything better to work with. *Maybe there's a reason why the people in the retirement park want a newspaper.*

Ideas came at him, faster than he could sketch them down on his pad. With Dad's gear, he'd build strips of receivers and boosters for several different wavelengths. Stretched across the rocket's skin, the entire ship would be the antenna.

Wow!

Dave went to work, designing, compromising, and redesigning controls for the rocket's flight, the microwave receiver and communications with the ground. There was no question in his mind which two took precedence. But he didn't want the guys to think he was execing them. He wasn't bossing an office; they were independent contractors, just like his Dad. The most important question he called the guys on.

"How interactive do we make this? Should I automate everything?"

Joe shrugged.

Terry shook his head, a grin spreading to his toes. "Your mom ever tell you to quit sitting around the house, do something. Go outside and play?"

"Yeah," came from the two others.

"Well, this time we are going to go *way* outside and play. I say make the Hawk *in-ter-act-tive* all the way. We bring our goggles and gloves. We fly with that sucker."

"Right way!" Joe shouted.

Dave wasn't so excited; Terry had named the rocket without asking anyone. Who was execing who? But Joe seemed happy. Dave shrugged it off. *Compromise, anything to touch a star.*

But the choices he made to optimize the chip set almost got him in trouble when Dad checked his design before sending it for tooling.

"You've deoptimized most of your flight controls, son."

The rocket wasn't going to fly that much, just straight up, but Dave couldn't tell Dad that. "Yeah, the software's supposed to take care of most of that."

Dad opened his mouth, closed it, and ran a hand over his chin. Finally he said. "You're going to flight test this?"

"Yes."

"We can afford to run a new chip after that."

Joe's dad took them out to a little-used drag strip for their test. While Joe and his dad fueled the Hawk, Dave and Terry set up the control center. Dave had designed all the software to interface with their VR gear, both glasses and gloves. They'd use the phone net to keep in touch with the Hawk. The net orbited at 150 miles and the Hawk would be just below 200 miles. The net faced downward, but their satellite should still be in range. Dave also liked to stay close to the net so he could get questions answered fast.

When the rocket was ready, Joe's dad headed for his truck and a beer and Joe trotted to join his friends. "She's loaded."

"Let's see what the Hawk can do." Terry started the countdown dramat-

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ically at sixty, which left Dave a whole minute to waste.

He checked the air traffic picture at Portland International; no aircraft were near them. An eyeball sweep of the clear sky showed no birds; it would be lousy luck to lose their project to a dumb animal.

The Hawk fumed on the pad. It was delta shaped, like a real spaceship, even though she wasn't much bigger than a fifty-five gallon drum. The bottom was three feet across to give the landing gear plenty of spread. The nose cone reached six feet from the ground. Strips of lead foil spread like a star burst from the nose to the bottom, standing in for Dave's conformal receiver array. Today was just a test for the vehicle. Today, Dave would not touch a star, but he was getting close—close enough to feel their warmth on his face.

Terry reached ten. Dave did a quick check; everything in his glasses was green.

"Two, one, ignition."

Fire spewed from the bottom of their creation. For a heartbreaking second, it stopped, then caught again. In the blink of an eye, the rocket was off and climbing. Instead of a slow haul up to two hundred feet, it was going like a skate board on black ice. Dave glanced at Terry; his glove hand was all the way back.

"Wow," Joe had eyes only for his baby.

"Terry, we've got to land this thing. Slow down, you'll wreck it."

Terry ignored Dave.

Dave started to grab Terry's control hand, then froze helplessly in place. What Terry was doing was bad, but the commands the Hawk would get if the two of them got into a shoving match were worse.

Finally, Terry's hand bent forward. Dave watched on his glasses as the rate of climb slowed—and the engine hiccuped, sending a shock through the entire structure. Dave prayed the connectors on the com unit held together.

As Terry slowly brought the vehicle back down to where it belonged and went through the landing procedures, Dave's instruments reported two more instances of fuel starvation. As soon as the Hawk touched down, Terry and Joe started celebrating, pounding each other on the back.

Dave didn't have time; something was wrong with his ticket to the stars. Anger knotted his stomach. Dave wanted to smash Terry with something heavy, for risking the stars and for whatever Terry overlooked when he designed the fuel system. There wasn't time for anger this afternoon. Dave locked it away in a box and went hunting for what was wrong.

On the net he first pulled up a schematic of the Hawk and the school rocket. They looked different, but the systems were the same. Next he brought up a simple outline of a DC-3 and launched a search program to match its fuel systems against the Hawk. It only took a second to spot the difference.

"Guys, we got a problem."

Terry whirled. "What do you mean? It worked perfectly."

Dave's anger shot out like a jack in the box. "Like hell it did. We had fuel

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starvation to the engines four times in the flight."

"But I'm using the school's pumps," Joe defended himself.

"We're doing a lot more with those pumps than the school ever intended. We need pressurized fuel tanks. We can't just pump fuel. We've got to push it out at the same time." Dave passed what was showing on his glasses through to theirs.

Terry fumed for a second, but, as his eyes flitted over what showed on his glasses, his face went to a puzzled frown. In a minute he focused on Dave. "You're right."

Dave put his anger back in the box. The guys weren't stupid. Dumb sometimes, but not stupid. "That's what they do on a DC-3."

"Shit," Joe shook his head. "My Dad does helium welding, so getting it isn't a problem, but a bottle of that stuff and tubing will weigh at least a pound." An extra pound of structure meant twenty-three more pounds of fuel and three more cubic feet of missile.

"I've been saving a half-pound reserve. You can have it." Dave offered.

"This'll use up what we've saved too," Terry said sheepishly. "We're out of luck if we have to add another ounce."

Two weeks later, the rocket was ready for the science fair, but systems integration was going on even as the judges circulated. Mr. Montgomery showed up just before the judges with Ms. Harrison, the principal. "Here's one of this year's most exciting projects, for the whole city," he told her.

"And what are you boys doing?"

That was Dave's question. "We will determine if the microwave radiation left over from the Big Bang was equal in all directions. We have designed instrumentation to measure the background microwave radiation from that event." Mom's last words to him this morning had been to speak slowly and say his words properly; Dave was just glad his voice didn't squeak.

Ms. Harrison seemed impressed. "I remember when those results were first published. It was earth shaking. To think, students at my school can repeat them. How do you propose to do that?"

The boys took turns explaining their "official" project. The principal nodded as she followed them. Dave concluded. "We'll be launching near Blue Lake early Sunday morning. There won't be much activity on the water and it will give us an extra 4,000 feet."

Ms. Harrison turned to Mr. Montgomery. "You're following all the safety precautions."

"Yes, I ordered the primer cord this morning. I'll be range safety officer."

"Good, I haven't been up to the lake in a while. I just might come," she said without looking back as she headed for the three girls who had grown a modified strain of bacteria to increase the recoverable rate of methane from closed landfills.

"We'd be glad to have you witness this project." Mr. Montgomery called after her.

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"Primer cord?" Dave's voice did break this time.

"Yeah. You boys didn't think we'd let an experiment as dangerous as this one go without special safety precautions. The chute handles problems if something goes wrong on the way down. The explosives take care of things on the way up."

"How much does it weigh?" Joe choked on the words.

"Oh, about a pound, including the detonator receiver. Why?"

"We'll need to make allowances for the weight." Terry said, glancing at the other two.

"You boys do that." Mr. Montgomery left.

"Don't say a word. We'll talk tonight," Terry ordered.

"Where are we going to get a whole pound?" Joe tossed his plans on the desk in Dave's room.

"I can scratch some of my receivers, but damn, all of them together don't weigh more than two pounds. We'll lose half our data."

"What about the parachute?" Terry asked.

"What about it? They'll check it before launch," Dave growled.

"Yeah, but will they measure how far the ropes stretch?"

Joe nodded, "I can trim them a bit, the chute too, and we've got a little extra room for fuel."

"Look at everything," Terry ordered.

It took them an hour. Here an access plate with four screws was replaced with a three screw version. There a support truss was pared down another .005 mm. A tiny fuel cell took the place of the solar panels.

"All we need is a couple of hours of data," Terry insisted.

Dave gritted his teeth and made the compromise.

It was almost midnight when Dave calculated the final weight scheme, then fed it through a ballistic simulation. "If the wind and weather are right, we make orbit," Dave concluded, pushing back from his desk. Before the others could start celebrating, Dave whirled his chair around. "But we don't have anything to spare. We'll have to make every burn count. I'll write the launch code." Dave fixed Terry with unblinking eyes. "The computer flies the Hawk."

"Right. Whatever it takes. You do it."

It felt good for someone else to compromise for a change.

The two left to make the changes needed to the Hawk. The first thing Dave did was erase the code for ground control of the Hawk's flight. *Touch a star.*

The launch pad was an empty concrete parking lot beside the lake. The high pressure front Dave was counting on had moved in during the night. The air was crisp and cool—and as thin as they needed. The chill had also cleared the lake of boats. Now if they could just catch a moment when the wind was nothing, they'd have it made.

The boys fueled the Hawk by first light. Mr. Montgomery and Ms. Harrison watched. Terry pumped hydro-

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gen peroxide from a fifty-five gallon drum that said 50 percent concentration. No one asked what it really was. Joe emptied three red, five gallon cans into the fuel tank, then poured some from a fourth. Joe's dad didn't say anything about it being JF-D, and again, nobody asked. Joe screwed the access plates on as Mr. Montgomery wound the primer cord and attached the detonator to one of the last screws.

They had trudged half way to their picnic table command center when Joe felt his pockets. "I shouldn't have any screws left." He pulled three out. Waving a screw driver, he took off for the rocket like a track star. "Get ready. I'll only take a second."

Ms. Harrison frowned. "I hope this won't be as bad as an old NASA launch. I have things to do today, but I guess you can't expect kids to stay on schedule like TWA."

For a moment it looked like Mr. Montgomery might follow Joe, but he patted his belly. "If I go, we won't launch before sunset."

Ms. Harrison laughed with him and they continued on.

"What do you think he's up to?" Dave whispered to Terry.

"I don't know, but we better be ready for anything."

The boys trotted for their gear. Dave quickly pulled on two gloves and a full helmet. He could clear it if he had to, but when he opaqued it, nothing would interfere with what he saw today.

Joe was frantically dancing around the rocket, hands waving, body obscuring what he was doing. Dave checked the automated launch sequencer. Everything was running smoothly. Whatever Joe was doing, he hadn't messed with anything important.

Dave did another traffic check. There was nothing on the Portland scope to worry about. Mr. Montgomery had actually got them listed in a Notice to Aviators. Blue Lake was closed to air traffic for the next two hours. *Nice to be able to count on adults for something, even if it was only to look after themselves.*

Kids were encouraged by TWA to catch the spaceliners moving across the sky at sunset; it was easy for Dave to tune into White Sands and get a complete dump of low orbital tracks. He played them across his helmet screen, cool purple against blue and green earth and black space. The Hawk's track was a bright red. Two sections flashed warning of close approaches; he reached out for them, tapped them with his finger—120 MILES appeared. FAA regs allowed for a hundred mile separation when crossing orbits. The Hawk would be OK.

"Whatever Joe was up to, he's coming in now." Terry's voice echoed in Dave's helmet. He cleared his visor; Joe was running toward them, grinning like a canary who swallowed the cat.

Mr. Montgomery looked up from his pocket computer; the screen showed he'd been checking air traffic. "What was it, Joe?"

"I goofed, Mr. Montgomery. I guess I had three extra screws. But I checked just to make sure everything

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was down tight. It is."

Ms. Harrison frowned and Mr. Montgomery went back to his computer. Joe joined his friends.

"What were you up to?" Terry hissed.

"I got our pound back." Joe pulled out the pockets of his jacket, then stuffed them back in quickly. But not so fast Dave didn't see a detonator in one pocket, primer cord in the other. "Now we'll make orbit for sure." Joe crowed in a whisper.

Terry patted him on the back. "We sure will, won't we, Dave?"

"You bet." *Like hell.* "Now Joe, I got to get busy." Dave opaqued his helmet and started talking fast to his computer.

"How bad did he louse us up?" Terry asked a second later.

"I need a half hour to reprogram all the burns."

"We don't have a half hour. What if we launch a pound light?"

For the briefest of seconds, Dave was grateful to Terry for not jabbing him about humans adjusting faster than computers. Then Dave's helmet flickered and a new red line appeared. "Our apogee is way the hell too high, and we're going to fry at perigee."

"The first time?"

Dave worked his fingers carefully over the orbit, weaving a rope that had to support his dreams. "I think we'll survive the first two, but I wouldn't bet on the third."

"We'd complete one orbit?"

"I think so."

"Then let's do it."

"Hold it. I've got to check the traffic in the higher orbits. We'll be five hundred miles up at apogee."

"Dave, we've got to move!"

"Not and kill someone." Dave kept his voice low enough the grown-ups wouldn't hear him, but not so soft Terry could ignore him.

"You got two minutes."

The high stuff was usually corporate, and they didn't care what kids were interested in. Dave's system accessed it; there was so much of it he shunted part of it to his dad's processor.

His helmet clock ticked. Orbits appeared on his display and he sent searches along them. There were close approaches. One was 101 miles. Dave checked it from three different perspectives: 101 miles plus a few feet.

"Dave, we've got to go."

"Give me a second. I'm almost done."

His helmet beeped; all the orbits were plotted. A second later, he got another beep; all orbits checked out. No more close calls.

"Go for it."

"Beginning count down. Ten. Nine."

Dave cleared his visor. This launch he wanted to see.

"Three, two, one, ignition," a forever pause, "lift off. She's off," Terry screeched.

"We did it," Joe danced a jig as he shouted. "We did it."

"Ten thousand feet and mission is nominal." Terry recovered his poise and deadpanned an old movie. "Twenty thousand feet."

"Twenty-five thousand feet."

"Thirty thousand feet."

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"I'm getting something." Dave tried to sound matter-of-fact, like a good test pilot. He cleared enough of his visor to check on the teachers.

Ms. Harrison shook hands with Mr. Montgomery, who turned to Terry. "Shouldn't you be throttling back?"

"Joe, give Mr. Montgomery his stuff back," Terry answered.

Dave darkened his visor to max and stared intently. It was hazy, but stars were starting to sharpen into points.

There was noise—in the background and on his instruments. Ms. Harrison's "You can't do this," came through loud and clear, but that was Terry's problem. He wanted to be a manager like his dad; he could practice handling people. Dave watched as the stars came out.

At first, he could only watch. The Hawk was going up and Dave only saw what it was pointed at. He checked the recorder. His main computer at home was catching it all. The net satellite acquired the Hawk as it went by. Dave quickly modified his communication program to patch into higher comsats. He attached to them smoothly, but the phone bill next month was going to be as high as the Hawk. *Well, Dad said he'd help.*

ENGINE SHUT DOWN flashed on Dave's visor. The Hawk was his. He took over the gyros and started covering the sky.

"How we doing?" Terry asked when he rejoined the net.

"Perfect, I'm just starting the sky sweep. How are things?"

"Ms. Harrison stomped out of here. She wants to see us in her office first thing tomorrow morning."

"How's Monty taking it?"

"Better than I thought. He left with her, but he's got to be there with us tomorrow."

"Then we better make this count."

The stars were out. The recorder was on. For the rest of his life, he would have this program to play on his Virtual Reality. Today he didn't want to miss a second.

The Big Bang's background was why they were here, and Dave had a couple of automated programs to hunt for the tiny fluctuations in the microwave background that meant so much to the grown-ups. He checked one; the incoming data was red, historical data yellow. Most of the sky was orange—but not all. Dave zoomed in on a tiny red fringe. It reminded him of wind blown wisps of clouds at sunset. *Interesting.* But that could wait. Dave was here for the stars.

He found one, not a point like the others. This one had wings, jets of gas shooting out from its core in both directions. Here was a young star; a kid like himself who didn't know better than to do dumb things.

Dave reached out, touched the teenage star. Letters and numbers appeared next to his glove, telling him things grown-ups had discovered about his star. They'd found out facts. He'd found a friend.

The search program rotated the Hawk; there was a lot of sky to cover. Dave found another young star to touch. Every part of the sky they surveyed had new stars in it. It made Dave feel right at home, friends wherever he looked.

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Two hours later, Dave surfaced when the background got hazy. "What's happening?" He asked, not expecting any answer.

"I think we're burning up on reentry." Terry replied.

For a moment, Dave could feel the heat, and he wanted to cry, for the Hawk, and for his new friends, now locked away above the sky. Dave might have sat down and bawled, but Terry and Joe were there.

Nobody said much as they packed everything into the truck. Joe's dad was finishing up a six-pack. He let Joe drive them home.

"What you boys did was foolish. It was dangerous, and it was against the law." Ms. Harrison waved a hand full of faxes. "I've had letters of complaint from half a dozen agencies, some of them international. You came within fifty miles of a JAL flight. What did you think you were doing?"

"But I checked," Dave yelped, then bit his tongue. He knew that wasn't a question he was supposed to answer, but he *had* checked.

"It was a non-scheduled out of Osaka," Mr. Montgomery put in. "It filed only minutes before you launched and it hadn't made it to the public bulletin board yet, David."

Dave shut up; he'd take his medicine like a man. *But I've touched the stars.* He tried to listen as Ms. Harrison plowed on, describing the international treaties they had broken, but it was hard. His eyes kept filling with stars, stars he knew. For two hours he had soared among them, shared their freedom, felt their clear light. *Nobody putting me down. How do I get back up there?*

The fax machine beside the principal beeped and oozed out a page. She grabbed for it, another bucket of gas to throw on the stake where she was burning them. Her silence pulled Dave out of himself like her anger hadn't.

Ms. Harrison's eyes were wide in disbelief as she half mumbled, "This is from the headmaster at Stephen Hawking High."

Dave blinked. "Hawking?"

She turned on them, her voice shrill. "Which one of you young terrorists had the gall to brag about your escapade of yesterday?"

Dave shook his head, glanced at Joe and Terry. Their mouths hung open.

Mr. Montgomery coughed. "I, uh, considered this one of the more noteworthy physics projects this year, and I passed a complete backgrounder to Hawking last week."

Ms. Harrison glanced at her subordinate, then at the fax. "But this is talking about the results of Sunday's fiasco?"

"I was getting a full data dump from the payload," Mr. Montgomery shrugged with both hands. "I had a relay set up to Hawking. I guess I forgot to kill it when things took off on their own."

"We will talk about this later."

"Yes, ma'am."

The principal turned back to David, the distaste on her face one teachers usually saved for lectures about social diseases. "For some reason, they have seen fit to give you second place."

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"Second place," Joe groaned.

"Who got first?" Terry asked.

"There is no reason why I should answer you, but I will."

Dave figured the answer would be given with a two by four.

"Three young men orbited a satellite the proper way on Saturday. They launched it from Cape Canaveral with the approval of the test range there. They also designed their satellite properly. Any deep space probe will not have people to control it. Theirs was no souped-up joy ride. Theirs was properly operated by its onboard computer."

Dave risked a glance at Terry. *Go outside and play.*

Terry gave him a who-knows-what-grown-ups-want shrug as the bell rang for first period.

"Report to your classes. I will expect to see you at detention every Saturday for the rest of this year. Mr. Montgomery will oversee you."

The boys couldn't have evacuated the room faster if it had been a holed space station.

"Sir, we're sorry we got you in trouble." Terry was mending fences, a good idea if they were going to spend their Saturday mornings with Mr. Montgomery.

"Don't worry, fellows. I'm on leave of absence from Boeing. I can go to a lot of places. But there is something I've got to say to you."

Dave and Joe gathered around, ready for one more dressing down.

"That was one beautiful piece of work. The headmaster at Hawking has his honors physics class chasing down the change you spotted in the cosmic background. Nobody's got a clue why, but they're all excited." Mr. Montgomery looked squarely at each one of them. "I'm going to keep my eyes on you fellows. I expect you to go far, if you don't kill somebody first. Remember, safety before anything else."

"Yes sir," Dave answered with the others. Dad had said they'd done good too, once he was sure no one had been hurt. Dave hadn't really heard much of what his Dad said; Mom had sent him to his room with a block on all access—even games. Now, Dave tried to soak in Mr. Montgomery's words, hear them, feel them, believe them all the way down to his toenails. *We did do a pretty fantastic bit of work!*

"Now get to class, you bozos."

As they hurried down the hall, Joe spoke first. "Second place is half a scholarship. Damn! My folks still can't make that."

Terry worried his lip. "My Dad told me last night he'd been saving his bonuses the last two years. He thought that would cover me next year. With the scholarship, that would stretch maybe two years. But I'd miss you guys. I don't know, maybe I won't go."

Dave shook his head. *I've touched the stars, danced with them, fast and free as light. Nothing's going to keep me down here now.* "Hey guys, there's this paper route. It's not much, but with the scholarship, it ought to pay for Joe and me."

Compromises. My friends aren't stars, but where would I ever find a better bunch of guys? Delivering pa-

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pers to old folks who made a world that hardly talks to them—I can relate to people stuck on the outside looking in. It might be fun getting to know them. Maybe all compromises weren't so bad.

Joe shrugged. "I don't mind a little work. Why not."

Dave put his arms on his friends' shoulders. "If we pull together, there's nothing we can't do. We can even touch a star." ■

IN TIMES TO COME

Our March issue features a rare treat: a new novelette by Poul Anderson, with a most striking cover by George Krauter. Anderson is rightly renowned as a master world builder, and in this one he shows us a most exotic place and lifeform. For that matter, the human explorers who discover it are themselves a bit exotic; human nature *will* change, dramatically, in the centuries to come. But there may be an important element or two that persists through even the most dramatic changes. . . .

The fact article also represents a return to these pages by someone who's been away too long: Dr. Robert L. Forward. Faster-than-light travel is something that science fiction writers have long used heavily and physicists have usually dismissed as impossible—until recently. John Cramer's last couple of Alternate View columns have given you a brief survey of a recent NASA symposium on ways it might be achieved after all. Next month Forward, another participant in the symposium, gives a more in-depth look at some of the possibilities.

We'll also have short fiction by Hayford Peirce, Amy Bechtel, and James Gunn, as well as the conclusion of Robert J. Sawyer's serial *Hobson's Choice.*

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BIOLOG Jay Kay Klein

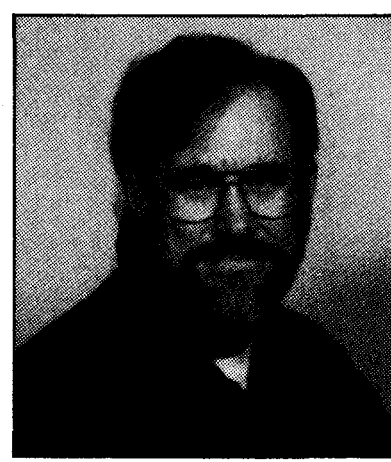
Mike Moscoe was born in the Philadelphia Navy Yard hospital. His father was a career Navy officer specializing in electronic countermeasures until retirement as a Lt. commander. Mike grew up just about anyplace you could park an aircraft carrier. Not until high school did he actually spend a full year in the same school.

Thinking to capitalize on his unusual first-hand knowledge of geography and experience with widely differing people, Mike pursued a BS in International Relations at Old Dominion College in Norfolk, VA. His first job took him back to Philadelphia, at the government's insistence it could put anybody it wanted into the army even if he showed no aptitude for it. Basic training proved a draw, with neither side getting anything out of it.

Finally a civilian, he joined the Navy Department briefly as a budget analyst. Having grown up as a Navy brat, he thought he knew all there was about doing things the Navy way. Try as he could though, his first assignment, trying to balance the barracks' painting account, baffled him. It seems they had hidden the money for refitting a battleship in there.

With the Civil Service Commission, he broke into writing, answering letters from irate people who had flunked their exams. Transfers came to the Federal Highway Administration, U.S. Bureau of Mines, and U.S. Bureau of Land Management. He has hacked out instruction memos, performance standards, and labor contracts. Seven years ago he joined a special two-year project that he's still working on to construct an environmental map locating trees, rivers, roads, spotted owls, and other hapless creatures in Western Oregon. He was awed by the endless complexity

Biolog continued on p. 103



Mike Moscoe

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Jerry Oltion

SCHRÖDINGER'S KILN

Some phenomena might appear quite devoid of practical applications, but. . . .

Illustration by Steve Cavallo

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When her finger caught in the smooth wall of red clay and the nearly finished stoneware mug ripped apart like a house under a tornado, Mary simply lifted her hands from the wreckage and watched it spin around and around atop the wheel's muddy disk. She didn't get angry. She was way past angry. This was the fifth mug she'd ruined today, and she'd used up all her mad after the second. All the same, it was more than simple fatigue that made her hands shake now. That was her livelihood spinning around on display before her.

She fumbled with her left foot for the power switch, finally kicking it with her big toe. The lump of clay coasted to a stop, and now that the electric motor's whine and rumble had quit, the only sound in the studio was the classical music coming from the radio on the drying table beside the wheel.

The table with only two mugs on it, where there should have been eight.

And of those two, only one was new today. The other had already been glazed and fired. Mary picked it up without bothering to clean the mud off her hands and tilted it to her lips.

Gah. Cold coffee.

Leaving the ruined mug on the wheel, she stood and carried the half-full one through the clutter of packing boxes and clay sacks into the kitchen, where she opened the microwave oven—and stopped. There was already another mug sitting on the glass dish.

Lord, she thought, how long has that been there? Since yesterday, at least, because she only used one mug a day. She took the old one out and replaced it with the new one, then closed the door and pushed the one-minute button. Her finger twitched and she got two minutes instead, but the light came on and the carousel began revolving slowly while the microwaves did their thing. Mary turned to the sink and washed out the old mug while she waited for the coffee to heat.

There was no denying it any more, she was falling apart. Age and arthritis had made her hands unsteady, and now her memory was failing, too. Pretty soon it wouldn't matter how many mugs she could make in a day, because she wouldn't be able to remember who had ordered them.

At least she hadn't started collecting cats, the way so many old women did.

She looked back into the studio—which used to be the dining room until she'd grown tired of carrying clay up and down from the basement—at the mess on the wheel. The lack of cats was little comfort when she couldn't even fill a simple order for a set of mugs. For that matter, the wheel itself was a constant reminder of her decline. She'd always hated electric wheels, hated them with the artist's disdain for mechanization, but her legs could no longer push a foot-wheel all day.

The microwave beeped softly, but the coffee aroma leaking out around the door drew Mary's attention even more. She'd overdone it. The coffee had boiled. Sure enough, when she opened the door, there sat the mug in

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a puddle of foamy brown stickiness. Sighing she lifted it out by the still-cool handle—amazed as always at how the oven could heat the coffee but not the cup—then drained it into the sink and washed out this mug, too. To hell with coffee; she didn't need any more caffeine making her shake, anyway.

There wasn't room in the rack for the second mug. Puzzled, Mary turned around with it still in her hands, scanning the pottery-filled shelves that lined the studio walls. Had she taken it from one of the finished orders? No, each set was complete, plates and saucers and mugs stacked neatly in rows, waiting for customers to pick them up or for Mary to mail them out. She wondered if she'd accidentally shorted someone when she'd packed an order. Must have, she supposed, carrying the extra mug across the room to set it in a gap on the shelves. No telling which order; all her mugs were the same nowadays. Her trademark design hadn't changed in years.

Well, whoever it belonged to would no doubt call to complain when they unpacked the box. Disgusted with herself, Mary went outside to stand for a moment in the back yard and take a breath of fresh air. Late evening light filtered through the apple tree next to the house, and the breeze carried the scent of its blossoms. Ah, yes, that felt good. Maybe a walk would help calm her down even more.

She didn't exactly get lost. Disoriented was more the word for it. The neighborhood had changed so over the years, none of the landmarks she remembered were the same anymore. She knew she would eventually find her way home, though, and she did, if a bit later than she'd expected. The Sun was already down by the time she spotted her familiar white house with its daffodils lining the walk. Tired, and a little bit scared, she switched out the lights in the studio and went straight to bed.

She had to chisel the ruined mug off the wheel in the morning. She should have done it last night, but she'd been preoccupied and she'd forgotten. Determined to do better today, she set straight to work on the mugs, and she finished two in a row before her hands grew tired and she ruined the third. She'd been expecting that, so she switched tactics, making a few of the easier plates and bowls so she wouldn't have to do all the difficult work at once. It seemed to help, though she ruined a few of those, too.

Over the next few days she did manage to finish a few complete dining sets, but only by working late into the night. By the end of the week she was exhausted, yet when she compared her output against the incoming orders, she realized she hadn't even come close to keeping up with the demand. Nor even to making a living. At this rate she would barely be able to pay her light bill.

She sat at her shipping desk, rubbing her eyes and staring at the clutter of papers. She needed to eat. She was tired and hungry and she hadn't eaten since—when? She couldn't re-

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member. Hadn't she heated up some leftover spaghetti for lunch? If so, she didn't remember eating it.

Good grief, no wonder she felt so wrung out. She went over to the microwave and opened the door. Sure enough, there sat the plate full of spaghetti, still cold, or cold once again. She gave it a couple of minutes on full power, watching the carousel spin slowly round the whole time so she wouldn't forget it again, then she set the plate on the counter and ate standing up. When she was done she put the plate in the sink—right on top of the one she'd used for lunch.

The hair on the back of her neck stood straight out. She *had* eaten lunch; she remembered it now. So where had the extra plate full of spaghetti come from?

The same place the extra mug had come from, no doubt. But where was that? Certainly not another shorted customer.

Nobody called to complain all next week, and after four more mugs and a bowl of soup showed up in the microwave, Mary reluctantly concluded that they were somehow appearing out of thin air. It didn't happen every time. Most of the time she got out only what she put into the oven, but every now and then—when she was most confused, it seemed—she would get something new. It was spooky. For a while she was afraid to go near the thing, but once when she finally forgot her fear and tried to warm up a cinnamon roll, she found half a dozen plates, three mugs, and a gravy boat all crammed inside the tiny compartment.

It apparently had something to do with her forgetfulness. On good days, when her memory was working the way it used to, she never got anything new out of the microwave. But on bad days, when the likelihood that she had forgotten something in there went way up—that's when it happened. She tried experimenting with it, popping open the door whenever she went past, sticking things inside and leaving them for varying times, even putting in things she normally wouldn't put into the oven, but like a watched pot that never boils, the microwave refused to perform until she truly forgot what might be waiting for her.

By the end of the second week since she'd noticed the phenomenon, she had a complete dinner set, and the pace was accelerating. Her unsteady hands and her experiments had eaten into her production time so badly that she was behind on her orders, so she did the only logical thing: she packed up the newfound pottery and shipped it out to the longest-waiting customer.

After another week she had filled half her orders the regular way and half with the microwave, and in the process she had come to understand the rules, if not the theory behind these strange manifestations. There had to be at least *some* chance that she had left an object in the microwave, and she had to honestly forget whether or not she had, before it would happen. But with her failing memory, the odds of that being true had grown from a rare event to near

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certainty.

And now she began finding mysterious casseroles in the refrigerator, vases full of dead flowers in the breakfast nook, and even extra cash in the sugar bowl where she kept what she had always laughingly called her "mad money."

Life settled into a strange, but comfortable, new routine, one that could have continued indefinitely without further complication if curiosity hadn't eventually overcome her. On one of the rare days when her arthritis wasn't bothering her too much to get out and her mind felt too lucid to allow any spontaneous pottery, she went to the library, determined to discover how this could be. She spent an entire afternoon in the science section, starting with microwaves and progressing to waves in general, then to particles and the physicists who worked with them. She read about Einstein and Dirac—and Schrödinger. The man who had proposed the odd notion that a cat in a box might be both dead and alive at the same time until someone looked to see which it was, and therefore forced the Universe to choose.

Change the conditions just a bit, with a forgetful person and a microwave oven, say, and Mary could easily see how her condition could force the Universe to choose between emptiness or a piece of pottery.

She returned home that evening in a pensive mood, circling warily around the kitchen. She'd had enough strange physics for one day. She headed straight for the bedroom, kicked off her shoes, and collapsed on the bed without even removing her clothes. But she had hardly begun to relax when she heard a noise, a tiny scratching sound, from within her closet. She raised up, staring at the door. Was that a meow she heard? Could a cat have somehow gotten into the house, or was she just responding to the power of suggestion from reading about Schrödinger's experiment?

Slowly, carefully, she lay back on the bed, unwilling to get up and see. ■

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THE ALTERNATE VIEW: by John G. Cramer

NASA GOES FTL PART 2: CRACKS IN NATURE'S FTL ARMOR

This column is the second of two about the Advanced Quantum/Relativity Theory Propulsion Workshop (AQRTP), a gathering held at the Caltech Jet Propulsion Laboratory which I attended May 16-17, 1994. It was sponsored by NASA's Office of Advanced Concepts and Technology, and its purpose was to bring together a group of experts and interested parties to review quantum mechanics and relativity theory as applied to concepts like space-time wormholes, trans-relativistic physics, space-time structure, and quantum nonlocality. In other words, we were to brainstorm possible physics routes to faster-than-light (FTL) travel and/or communication. The AQRTP Workshop was organized by Dr. Robert H. Frisbee of JPL, with some help from Bob Forward.

In my last AV Column I wrote about our new ideas on wormholes, which have now resulted in a physics paper already submitted for publication, with six of the Workshop attendees as co-authors. In this column I want to discuss the other items on our FTL agenda. Like wormholes, some of the other FTL loopholes that we discussed have been featured in my previous AV columns.

The Casimir Effect (see also my column in *Analog*, Mid-December, 1990): Quantum theory tells us that "empty space" is not empty at all. At the quantum level it is full of fireworks made with virtual particles—quarks and antiquarks, electrons and positrons, photons and neutrinos, that flash into a brief existence and disappear again, their short life spans made possible with energy borrowed on Heisenberg's credit card, i.e., from the time-energy part of Heisenberg's Uncertainty Principle. The existence of this quantum fireworks gives a certain energy to the vacuum, energy that is in principle there but that cannot normally be measured or changed.

There is, however, a tricky way of changing the vacuum energy. It is called the Casimir Effect. If one places a pair of grounded conducting paral-

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lel plates close together, with only a narrow gap separating them, some of the quantum fireworks is suppressed. The virtual particles cannot exist if they have a half-wavelength greater than the gap between the plates and interact electrically with the plates. The energy reduction result is that the vacuum energy between the plates is reduced as the fourth power of the plate gap distance. This energy reduction results in a net force pushing the grounded plates together, a force that has been measured in the laboratory.

The Casimir Effect is relevant to FTL considerations because it has been predicted from quantum electrodynamics that the speed of light is greater in the energy-depleted vacuum between the Casimir plates than in free space. This increase in velocity is a tiny effect because the amount of vacuum energy depletion possible in practical Casimir experiments is small and because the speedup of the light velocity **c** (normally a fundamental constant defined to be exactly 2.99792458×10^8 m/s) depends on the amount of energy removed.

The idea suggested in our AQRPT Workshop was that one might conceivably surround a space vehicle with a "bubble" of highly energy-depleted vacuum, in which it could travel at FTL velocites, carrying the bubble along with it. This speculation produced the following thought experiment. Suppose that one produces an energy-depleted region of space using the Casimir Effect and then somehow makes the parallel conducting plates disappear. What happens to the "bare" volume of energy-depleted space left behind? Does it return to normal space? If so, where does the energy come from to make up for the energy that is missing? Does the volume of energy-depleted space persist as a "bubble"? If so what shapes does it assume? Does it expand or contract?

We were not able to answer these questions at the Workshop. Physicists often generate more questions than answers.

Quantum Nonlocality (see also my columns in *Analog*, January 1990 and October 1991): Quantum mechanics, the theory describing the behavior of matter and energy at the smallest distance scale, implies the persistence of correlations between the separated parts of an overall quantum system, even when the parts are separated by light-years of distance. These correlations manifest themselves instantaneously in all parts of the system whenever a measurement is performed on any part of it. This property is called *nonlocality*, and it carries with it the implication that nature arranges such correlations using some faster-than-light linking process. Einstein called nonlocality "spooky actions at a distance" and regarded it as demonstrating a fundamental flaw in the formulation of quantum mechanics. However, from the experimental tests of Bell's Inequality, we now understand that quantum nonlocality is "not a bug but a feature," as the programmers say.

At the AQRTP Workshop we considered the question of whether

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quantum nonlocality was a possible medium for FTL communication. In the context of standard quantum mechanics there is good reason for believing that it is not. Eberhard has proved a theorem demonstrating that the outcomes of separated measurements of the same quantum system, correlated by nonlocality though they are, *cannot* be used for FTL observer-to-observer communication. A possible loophole in Eberhard's theorem could arise if, following the work of Nobel Laureate Steven Weinberg, one modifies conventional quantum mechanics by introducing a small non-linear element into the standard QM formalism. It has been shown that in slightly non-linear quantum mechanics, the observable nonlinear effects that would arise would make possible FTL communication through nonlocality.

This result is not particularly satisfying because the experimental work, mainly in atomic systems, that followed Weinberg's description of nonlinear observables placed very low upper limits on the possible size of such effects. Our AQRTP Workshop participants turned to the question of where one might look for quantum nonlinearities with a better chance of finding them than in atoms. We concluded that such a breakdown in quantum linearity would most likely be observed at the smallest scales of time and distance, i.e., in experiments conducted at the highest available energies. To our knowledge, however, the high-energy physics community has not given consideration to Weinberg-type quantum linearity tests.

* * *

Tachyons (see also my column in *Analog*, October 1993): Measurements of the mass of the electron neutrino in tritium beta-decay experiments at six different laboratories suggests that the electron neutrino may have a mass-squared that has a negative value. The statistical uncertainties in these mass-squared determinations are presently too large to be compelling, but the measured negative mass-squared values, if taken seriously, would require that the electron neutrino is a tachyon.

Tachyons are hypothetical could-be particles that always travel faster than the velocity of light and that slow down to closer to the velocity of light when they are given additional kinetic energy. The rest mass of a tachyon is imaginary (like the square root of -1), but the net mass energies of tachyons are always real because they are never at rest.

At the AQRTP Workshop we considered the possibility of tachyonic neutrinos and their implications for FTL communication. Indeed, it would seem that a FTL signal could be transmitted by creating an information-modulated beam of low-energy neutrinos, perhaps using an accelerator, and then detecting the modulation of the neutrino intensity at some distant location. The creation and modulation of such neutrinos are more-or-less feasible with current technology. However, the *detection* of the particles is not currently feasible. The only working neutrino detectors operate on neutrinos that have energies of around 1,000,000 electron volts,

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preferably much more. If electron neutrinos are tachyons, the experiments suggest an imaginary rest mass of around 10 electron volts (10 eV). Therefore, in order to exploit their tachyonic properties, one would have to be able to detect electron neutrinos with kinetic energies around 10 eV, or preferably much less. We have no way of doing this.

The Workshop kicked around the idea of accelerating target nuclei in a storage ring so that the nucleus to be transmuted by the incoming 10 eV neutrino beam would be accelerated into the neutrinos, providing enough energy for a nuclear reaction. This method is semi-plausible but would undoubtedly have severe problems with detection rates and with background processes. Our conclusion was that even if the electron neutrino is confirmed to be a tachyon in the next few years, the prospects for using it soon as a medium for FTL communication are very dim.

Extra Dimensions (see also my column in *Analog* April, 1985): The NASA organizers of the AQRTP Workshop asked that we consider whether some of the recent work on extra dimensions, for example the Klein-Kalusa theory that uses compactified (rolled-up) extra dimensions to explain the fundamental forces, has implications for FTL communication or travel. Our first-order answer was "no." Even if infinitesimal superstrings and/or compactified dimensions do provide the inner structure of the Universe, they do not offer any direct opportunity for breaking the lightspeed barrier.

However, Matt Visser offered a variant approach to extra dimensions that could provide such an opportunity. The basic problem with hypothesizing the existence of extra dimensions in which our Universe is embedded is to explain why we are not aware of them, and in fact see no evidence of them. The Klein-Kalusa theory solves this problem by "compactification," by looping the extra dimension on itself and reducing the radius of the loop to a distance scale at which it would have little or no experimental consequences. Visser has another solution: the extra dimension (or dimensions) form a bowl-shaped energy well, and our everyday world lies at the bottom of that well. Since the well-bottom lies at a single point in the extra dimension, we have no evidence of its existence.

To rise above the bottom of the well would require (a) adding energy to the system, i.e., doing work against the restoring force that holds the system at the well-bottom, and (b) acquiring momentum in the extra dimension that moves the system away from the well-bottom. We agreed that (a) might be easier than (b), but we had no real suggestions about how to do either.

The implications of this approach to extra dimensions is that the velocity of light might be different from c away from the well-bottom where we live and perform experiments, just as it is in the energy-depleted space produced by the Casimir Effect and discussed above. This, then, is a rationalization

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for the "hyperspace" described in countless SF stories. There could be a hyperspatial domain in which the velocity of light is higher than c.

Summary: On the second day of the AQRTP Workshop we covered many FTL possibilities. None of them have sent us running for a patent application form, but I think we came away from our discussions convinced that Nature's door is not absolutely closed to the possibility of FTL communication and travel. ■

Biolog continued from p. 93

of the ecosystem in even such a limited area.

Science fiction made an instant hit when Mike read a Heinlein juvenile book in the fifth grade. A few years later, he ran into *Analog* while babysitting. One of the first presents from his wife was a subscription to the magazine. Mike is pleased beyond description to be an *Analog* contributor himself.

In a writing course at a community college, he did a story about the SDI Star Wars shooting down Christ breaking orbit for a Second Coming. Editor Stan Schmidt thought this lacked a certain something. Baffled, Mike sought a second opinion from an instructor, who put his finger on the problem: "You need dialogue—you know, the stuff in quotation marks." Two years later, Dr. Schmidt bought a story with dialogue for the March, 1991 issue. More rejection slips later, a second story appeared for Mid-December, 1993.

Writing science fiction today can hardly be done by anyone who hasn't been around a while. Our view of the Universe and man's place in it is undergoing kaleidoscopic changes with every new scientific insight. Years back, the only changes in people's lives were slowly aging bodies, the repetitive cycle of seasons, and occasional natural or man-made disasters. Today, science drives most of the changes in our daily lives. Mike tries to show people beset with ancient legacies of hormones and hardening arteries having to deal with the latest innovations of a bewildering technology. ■

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J. Steven York

WALKING THE VIRTCH

Doors don't always lead where you expect. . . .

Illustration by Dell Harris

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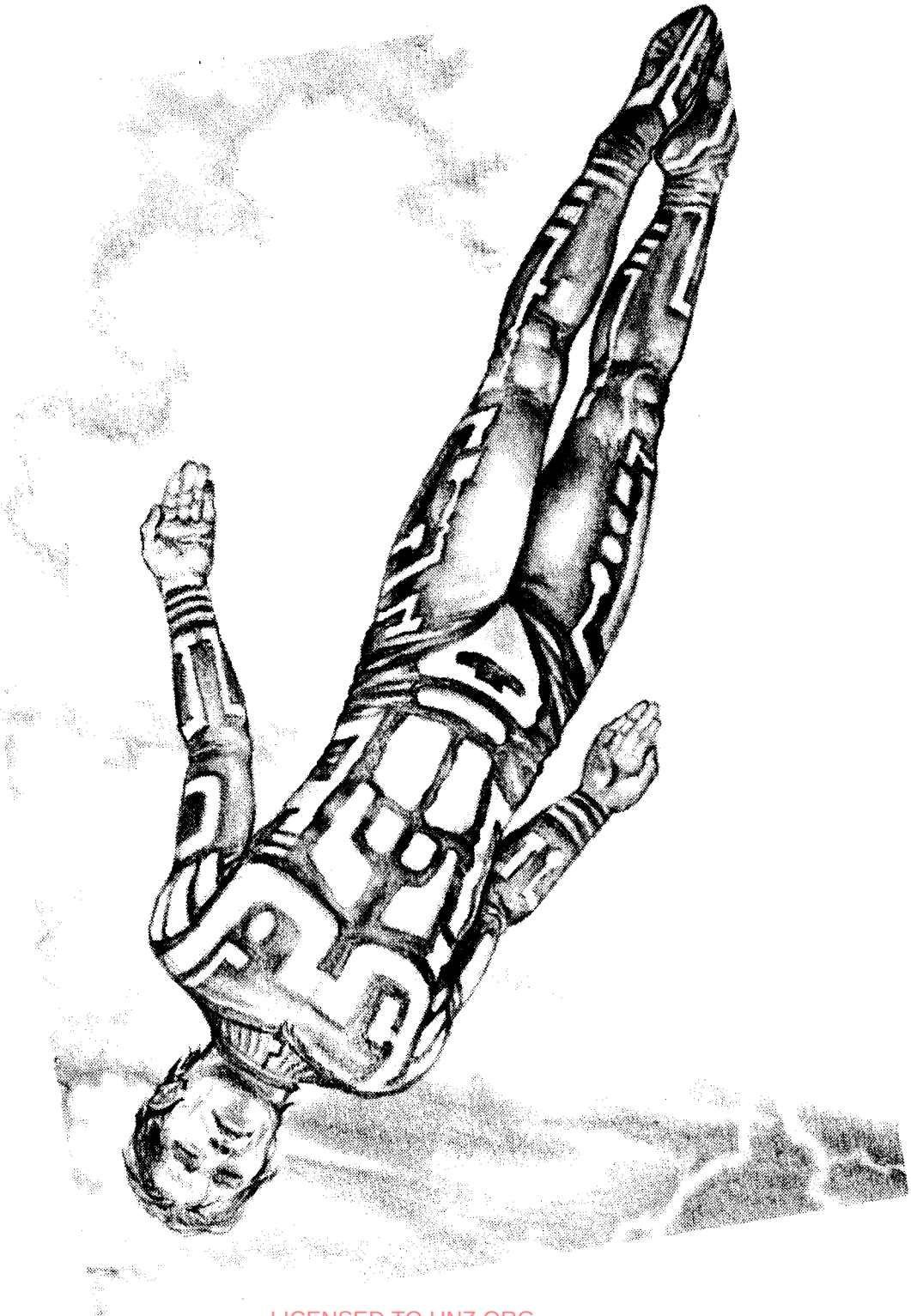

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Everything I know about flying I learned from Superman. Take three steps, extend your arms, push off with your toes. It's so natural, so easy, I'm surprised nobody thought of it before some early twentieth century comic hacks.

I netted somewhere that when Superman first launched the Real, little kids would tie towels around their necks and jump off the roofs of buildings. This was out in the Real, connect? Of course, the todds went flat mode. See, they thought it was the cape that let him fly? I could have told them. It's not the cape, it's the body language. The wiring is there in the human brain. You've just got to call the subroutine and do it.

Everybody flies in the Virtch. I guess they didn't connect that early on, when the Virtch was just a flash in someone's pan, and a few kludges in a laboratory somewhere. They figured everyone would be walking around the Virtch like regular old Real-morts. They should have vizzed at dreams. People have always flown in their dreams, like they'd been doing it all their lives, like they were *born* to fly. Maybe it's a womb thing, but they say all healthy humans fly.

But healthy is the operative word. When the Virtch started to come online big, the Brains found out that everybody wanted to fly, but not everyone could. Hey, the Virtch program was there, but some people were inhibited. Almost everyone flies when they're a todd, but back then they figured most people "grew out of it." But what was really happening was everyone's head was getting screwed up. Maybe in the Real it didn't show, but their pans weren't quite straight, and in the Virtch, it was plain for everyone to gog. So people got straight quick. The pshrinks worked mass bandwidth for a few years, because everyone wanted to do the Virtch, and everyone wanted to fly. And the world lived happily ever after.

But gog my theory. There's flying, and then there's *flying.* Most people fly the Virtch with a prop. Not a propeller; a gimmick, a crutch. Like, some people use skis, or a surfboard, or skates, or a sled. They never gogged Superman like I did. They think their pan is straight, but they don't know the true channel. They're almost as bad as those ancient todds with the towels around their neck. Like I said, there's flying, and then there's flying.

Yeah, I'm kind of an arrogant ass about it, but I don't fly the Virtch standing on a board. I don't have to pretend my feet are on the ground when they aren't. Three steps, arms out, push with toes. That's how long I was grounded. Three seconds, max. Crash, I'd have virtched into the sky, but the programs don't work that way. You start grounded out, then make for the sky. I think the software was designed by board addicts. Afraid to start with their feet off the ground. Crash 'em, I thought. Still do. Even when I walk the Virtch, I start from the sky. But that's getting ahead of the gog.

The First Time. Yeah, there had to be a first time. I'd had a hard day in the Real. I broker seafood extracts, mostly with the Japanblock Corp-

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Lords and the rest of the Pacific rim. You probably never gogged the business before, but we turn three trillion Commons a year in the Pacific trade alone. The stuff shows up in just about everything you eat, perfumes, sublimscents for adverts, and even the nose-phone of your Virtch-glove. It's a tough biz, even for the Real, fast and cutthroat. I'm good at what I do. It's like flying, except flying boosts, and the Real-biz tears you down.

So, I came home after turning 260 percent profit on eight-point-five-million Common, in only six hours. Good deal, but I was crashed. I nuked a shrimp-noodle bowl, pulled a cold-caff from the fridge, downloaded without tasting it, skinned on the glove, and Virtched it.

I needed to fly, bad. I did the thing, pushed off with my toes, and I was airborne. I went skydiving in the Real, once. Scared the crash out of me but it was great. Nothing like the Virtch though. Yeah, the clouds are there, and the feeling of height and infinite space. But skydiving is cold, and the wind tears at you, and your stomach is trying to come out your mouth.

But the Virtch is always comfortable. The air is like a warm bath, and the wind strokes your body like a lover's fingers. You can shoot through the sky like a bullet, or float like a balloon. You can go as high as you want, and you can always breathe even if you head out into space. You fling though a sea of pastel-colored clouds a hundred miles deep, each with its own smell: orange, or honey, or fresh-mowed grass.

If that's not enough, you look for the towering, black anvil of a thunderhead, and ride the updrafts, plummet with the hailstones, or dance with the lightning. Even in the middle of the thunderhead, there is just the hint of a chill, and the wind will clutch and toss, but never batter.

It started one day when Jace, Laddo, Buc and me were storm chasing. The three of them are all free-flyers like me, so we used to zoom together a lot. We spent hours chasing each other through the big anvils, riding the jet streams in tight formation. But that day, even as I chased the bolts between clouds and gogged a curtain of dancing Saint Elmo's fire ten thousand feet tall, it wasn't enough.

I peeled off the group and headed out without a word. They waved good-bye, but I didn't wave back. I whipped myself into a fast barrel roll and blazed out of the thundercloud like a powerdrill. Above, the purple edge of space gogged down like the eye of Allah, and below, the ground spread out like a fuzzy green carpet, so far down that the details were lost in the haze. I jackknifed my body like a diver and headed straight down. I must have been 20K meters off the deck, and it wasn't coming up fast enough to suit me. I posed myself faster, gogging in my mind that I was an arrow; a rocket, blazing toward the ground on a tail of flame. The ground was growing visibly closer now. I could gog more and more details: the blue varicose vein of a river, dark green scabs of forest, square patches of cultivated fields, jagged scars of roads, and occasional buildings like

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pockmarks.

I picked from my pan something I once gogged about people falling in dreams; that if they hit the bottom, they'll die of fright, and I wondered if that's how it happens in the Virtch. I'd never heard of it happening, but who'd be off their pan enough to try? So that's when I think I'm crazy enough to try. I posed like a knife, trying for a little more speed.

I saw the ground coming up at me and wondered what would happen. Would I crater? Would I flat mode? This was the Virtch. What happens when the unstoppable force wangs the immovable object?

I saw the ground coming up at me and admired the programming on the *trees and rivers and buildings. As I* spun I caught glimpses of oaks and alder, rapids bubbling over rocks, stucco and marble. A few people like to hug the deck when they fly. They like the sensation of speed it gives them. Somebody went to a lot of trouble for people who gog everything in a blur.

What happens when the unstoppable force wangs the immovable object? I'll tell you. The rules change. One second I'm maching down out of the sky like a meteor, then the next, it's like I hit a wall of syrup. I pose like a razor, but it's no good, I touch the ground like a snowflake.

So, I sat curled up on the ground, face buried in my knees, my pan totally crashed. What the crash was I doing? What the crash was wrong with me? Was I trying to die?

But after a while, I glommed that dying isn't my channel. What is was that my spiritual buffer was empty. The Real was—well, the Real wasn't real. I'd lived in the Virtch since I was sixteen, when my mom gratefully bought me my first glove, a bottom-of-the-line Sony model with no spensors and only a one-K nose phone. But I was glad to have it, and she was glad to have me out of the way. No more dragging her back from the Virtch (we lived in a one bedroom shack, but she had a high-end Apple glove with all the options) for any of that silly kid crash. Jodd had a new babysitter now, and mom cut her time in the Real back to a min. She did her nine to three at the bank, gloved in, and was gone.

I never really knew my mom *before, and I hardly saw her after. I tried* to find her in the Virtch one time. Yeah, that's not supposed to be possible unless the person wants you to find them, but I was a smart kid, and I did a little Virtch-jacking in my time. So I jacked my mom's coords from the master-map and tracked her down.

She was in a cloud villa of a private-sky, but if you've already jacked the master-map, getting into a private-sky is nothing. So I found her in the villa doing this group thing with a flock of studs and bims. She looked different in the Virtch. If I hadn't had my jack, I wouldn't have recognized her. I still looked like my Real mode back then. I knew you could look like anybody you wanted to in the Virtch, but I figured it was just one of those things other people do.

So she looks up from what she's doing. She's this beautiful bim, looks not much older than me, and she's

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naked and her skin is shining from some kind of oil. And she looks at me, and of course she recognizes me. Her eyes get wide and angry, and she points at me and yells, "Get out!" Then she looks down at herself and flickers into pink smoke as she Virtches out.

And some of the studs and bims who weren't too distracted noticed, and were looking at me. Then somebody far away called my name, the Virtch went black, something invisible hit me, and I felt myself falling. And the hood of my glove gets pulled off, and there's my mother, still wearing the wrinkled gray skin of her glove, just jacked out from the rest of the machine. Her face was red, her eyes all narrow, showing the lines there, and she's yelling at me, pushing me. She picks up my glove console and throws it at me. I duck, and the box bull's-eyes a stain on the wall behind me, breaking open like a melon, exposed guts falling to the floor.

I can see her in my pan now. I can see her like she's standing right in front of me. But I can't hear what she's saying. I feel like, if I concentrate hard enough, I might be able to read the words on her thin, dry lips, but I can't hear her. But I can smell the apartment, the dust, the mildew in the window frames, the sour smell of ripe garbage. I can see the anger and indifference on her face. I can see the lines of coming age there. I can see the smoky blue light from the one window, and the black scab that was the building across the alley. I knew then and I know now that, for my mom, *I* was the Real, and for her, the Real was unbearable.

I moved out of her place the next day, and in with my friends Laddo, Buc, and Pax from school. We were all Virtch-jackers back then. They helped me patch up my glove console. In a week, the longest week of my life, I was back in the Virtch, with a new job, a whole new life in the Real, for what it mattered. Actually, it mattered a whole lot. You have to eat in the Real, pay the rent, and upgrade your glove. The rig my mom had was nice. Mine was going to be better, I promised myself.

We lived fast, hard, and dangerous, jacking the Virtch for pay. They say the couple that Virtch together stay together, but a lot of couple-contracts Virtch on their own, and their ess-oh's will pay to tab on what they do there. So we gogged them on the sly, like old-time private-eyes used to do in the Real, and recorded their affairs for their lady or man to playback later. It didn't pay that much, and the risk was high, but we were kids and didn't know any better. After eighteen months, Pax saved enough to get his own place. Two months after that he was busted for Virtch jacking. He got ten years at hard labor. All he gogs now are rocks, I guess.

Laddo, Buc, and I legaled up real fast after that. We broke up in the Real. I don't even know what they're doing any more. But I still see them in the Virtch, and sometimes we fly together. I grew up a lot in the next few years. I did the school thing and the job thing. But I lived in the Virtch.

So there I was, sitting on the ground, doing the "what does it all

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mean," thing. I was curled up with my arms over my face, my eyes closed, and for a while I wasn't in the Real, and I wasn't in the Virtch. I was just in me. It was a strange place.

You know how you change channels in the Virtch? You make for a sky door and fly through, and you're in an intersection, a little chunk of sky with doors all around, and then you go through another door, and there you are in another channel; another sky. People don't linger at intersections. They don't think about them. They take them for granted. But they're the passages between all things in the Virtch. Without them, you'd be stuck in one sky, with no place to go.

So, there I was, face buried in my arms, knees to my chest, eyes closed, in my own dark little intersection, surrounded by doors, not just to the Real and the Virtch, but other worlds I'd never glommed before. Trouble was, it was too dark to see what was beyond the doors. That's when I smelled one.

It wasn't like the sweet smells of a pastel cloud, or the ozone of a thunderhead, or the musky perfume of a cloud villa. It had as much in common with those things as the Virtch did with watching a vid in flat mode. It was sweet and salty and sour and musty and a thousand other things at once. I'd glommed some power programs in the Virtch, but they were mostly for eyes and ears—cheap thrills. I groped for the door in the darkness and flew through. I opened my eyes.

I was sitting in a bed of dead leaves in a forest clearing. The trees that had gogged like bumps on a rug from the air towered all around me, rocking gently in the breeze. The Sun shown through the limbs, stenciling shifting patterns of light and dark on the ground. The sky was blue, and the pastel clouds and the sky villas were nowhere to be seen. Through some local piece of programming, a few wispy clouds moved slowly, colored only shades of white and gray. It was a beautiful piece of Virtch work, some of the best I'd ever seen. And it was here on the ground, where nobody would ever see it.

I stood up and brushed leaves off my butt. I looked at the sky. One, two, three, extend, and push. I'd have been back in my sky again. That was when it started. A path led off down a gentle hillside. Somewhere down among the trees, I could hear running water. It sounded inviting. I walked the Virtch.

The path wound slowly down the hill, around fallen trees and outcroppings of rocks. I'd lived all my life in the city, and I'd never seen anything this wild. Every few yards uncovered a new wonder: squirrels chattering and jumping from limb to limb, mushrooms pushing up through the forest floor like a metropolis of tiny buildings, red and blue birds soaring and wheeling between the trees, the strange calls of animals I didn't glom echoing between the hillsides.

At last I found myself looking down on a waterfall that tumbled over dark rocks three meters down into a deep, oval, pool. The water was so clear that you could count the rocks on the bot-

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tom. It looked inviting. On an impulse, I reached down and tested the water with my fingers. I had expected it to be as warm as bath water. It was cold. Not unbearably so, but the sensation was uncharacteristically harsh for the Virtch, enough so that I hesitated. The water still looked good.

I usually wear a jumpsuit in the Virtch, so I reached for the clasps. I could have derezzed the suit in a second by pulling up a console, but like I said, I'm a kind of Virtch snob. I keep the experience as pure as I can. So, I tossed my jumpsuit and slippers onto a rock next to the waterfall, but they derezzed as soon as they hit the ground, an interesting bit of programming. I could get them back by calling up a console, but it was strange. I guessed that the designer of this place valued the purity of their experience too, but they gogged purity differently than I did.

There was a rock sticking out next to the falls that seemed made for diving. I stepped out on it, feeling the Sun-heated stone under my bare feet, watching the water boiling at the bottom of the falls, it was a convincing illusion. Three steps forward, arms extended, push off with the toes. But *differently*, willing your body out and down rather than up, cutting a smooth arc through the air. I hit water so hard it took the breath out of me, so cold it wouldn't let me take any more in. You can't drown in virtual water, of course. I could have sat on the bottom all day if I'd wanted to (though it would have been pretty crashing cold!). But the illusion was so good that I held my breath until I broke the surface, gasping with lungs that didn't want to work.

When they finally did start to work again, I was laughing, loudly, uncontrolled, and without glomming why. I rolled over on my back and paddled toward the shore, enjoying the blue sky and the clouds, and the occasional interruption of a bird flying by. After a while, there was a whoosh, a Dopplered yell, and a couple of sky skiers mached over, trimming the tree tops and seeing nothing but blurs. It was then I realized, *this is what happens when you hit the bottom. You find what's hidden there.*

After a while I climbed out of the pool and sun dried on a flat rock by the water. Then I pulled up a console to bring back my clothes. It was then I noticed the clock on the fan-shaped control panel floating in the air in front of me—*2:38* A.M.! I had a sales meeting in the Real the next day. Noting the coords of the waterfall, I Virtched out and started peeling off my glove.

As I was getting ready for bed, I noticed the message indicator on the bedside console. I played back a flat mode vid from Laddo. I hadn't heard from Laddo in the Real in years. He'd been worried about the way I'd bugged out of the thunderhead and not come back. He said he'd even considered seeing if he could still hack the master map and track me down, but decided not to. "We're not kids any more, Jodd," he said. "Couldn't take the risk." He laughed at me from the screen. "Could end up breaking rocks with old Pax."

It was then I glommed what was

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wrong with growing up. You forget how to take risks. I thought about the ground rushing up at me, not knowing what would happen when I hit, and smiled. Sure it was a stupid thing to have done, but I'd felt more alive than I had in a long time.

Laddo ended his message with a request to call him when I got back to the Real. My finger hovered over the call icon on the console for a few seconds, then I tumbled into bed without pressing it. What was I going to tell him? That I was walking the Virtch? If he was worried about me now, that would really crash his pan. I needed my rest. I pulled up the covers, fell asleep quickly, and dreamed about flying.

It got to be a habit, walking the Virtch. Each night I came back and explored a little more of the private channel I'd discovered, bootlegged under somebody else's sky. I didn't see much of my friends in the clouds any more. I thought about telling them what I'd found, inviting them down. But like I said, there's a taboo about walking the Virtch, and they were purists, just like me. I figured they wouldn't understand. Crash, I admit it. I was shamed.

But when you find a great thing, you want somebody to share it with. That's why I was so jazzed to find Emily. I just wished she was as glad to be found. It happened one day when I was hiking down out of the high hills, back toward the waterfall and swimming pool. I was walking down the by then familiar path, when I heard singing. Not birds this time, but a woman's voice. It was a sweet voice, singing some old song, the kind with a melody. I came out of the trees, and there she was sitting on the diving rock. She was tall, and blonde, wearing a tan colored jumper that belted at the waist. She was beautiful—you expect that in the Virtch—but the voice had to be hers. Lots of people use voice mod programs, but they all sound terrible singing anything but buzz-rock. This was her real voice for sure. I stood quietly, listening, being very quiet so as not to interrupt. She just sat there, swinging her legs and gogging off at the horizon for a while. Then she pulled up a console in the air in front of her. Not a little homeent console like mine, but a big programmer's console with a sketch pad and utility keyball. She diddled the keyball for a minute, and a new hill rezzed in on the horizon.

"You programmed all this!" I said it before I had a chance to think about it.

She gasped, and her head spun around, fanning out her long, straight hair. Her eyes flashed from fear, to surprise, to anger. "What do you mean, sneaking up on me like that!"

I smiled at her. I was so amazed at her reaction that I didn't even think to be embarrassed that I was walking. "I was just gogging your work, here. It's beautiful."

So I stepped toward her, but in a second she's on her feet, and though she's dressed, she half turns away like she's trying to cover herself. "This is my place, you *pervert!*" And then she Virtches out, and I'm standing there by myself.

A few seconds later the landscape

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I'd grown to love is gone, too. It rezzes out, and in its place is a parody. The rocks are brown polygons stacked up like a kid's blocks, the pool a featureless blue oval, the trees indistinct green blobs on brown columns, the waterfall like a conveyer belt covered with glitter, running endlessly down into the bland surface of the pool. Yet, it would all look the same from a cloud villa. It was then that I glommed just how much of this place had been *her*. It was then that I knew just how much I'd lost.

I didn't do the Virtch at all for three days, the longest break since my mom threw me out. Instead, I vegged in front of my main screen and watched flat mode vids, drank too much, and generally got crashed. Finally, I decided to give the Virtch another try.

After I Virtched in, it didn't take me long to find Laddo and Jace. Buc rezzed in to say "hi," but he was spending a month on Mars for the Japanblock Corp he worked for, and the time delay was too long to fly the Virtch with us. So the three of us chased some storms, did some skygames, and cruised some cloud villas we knew. It felt like I hadn't gogged them for a long time, and I came pretty close to enjoying myself. But as the evening wound down, and it was just me and Laddo floating in the lounge of a cloud villa nursing a couple of beers, he started quizzing me as to where I'd been.

Turns out he'd finally gotten curious enough to hack the master map the night before, and found out I hadn't been in the Virtch for at least forty-eight hours. "Are you sick, Jodd? Never known you to miss a day in the Virtch. You find a woman?"

I didn't want to talk about it, but I figured it might be the only way to shut him up. "Yeah, I found a woman, and lost her, all at the same time. I don't want to talk about it."

"Is this in the Real or the Virtch, Jodd? Probably in the Virtch, I'm guessing." He took a swig of his beer and laughed. "Got to be careful about the Virtch, Jodd. It's good for most things including a quick, no hassles roll. But never love in the Virtch, Jodd. You never glom what you're dealing with."

I knocked my bottle off the table and it spun across the room before derezzing. I knew it was actually making a puddle on my living room floor somewhere, but there's no litter in the Virtch. So, I said, "I know exactly what I'm dealing with, Laddo, and *I don't want to talk about it!*" And I Virtched out before he could say anything else.

The comm rang a minute or so later, and I erased the message without listening to it. I was cleaning up the spilled beer when it rang again. I dumped the mess in the kitchenette, and started to erase the second message, then decided, what the crash, I should hear Laddo out. The message wasn't from Laddo.

The message was voice-only, but I would have glommed that voice anywhere. She said, "Jodd, this is Emily, from the Virtch. I hacked the master map to find your name and number, pretty easy in my line of business. I'm sorry about what I said, but the Park has been my secret for years, and

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you're the first person to ever find it. I was just—crash—like you caught me with my pants down. Look, you can walk there any time you want. I'm glad you like it. Maybe I'll see you there sometime. Maybe—" She hesitated, and I silently wished her on. "I'll be there tomorrow night at six thirty, if you want to be there."

Of course I wanted to be there!

Time in the Real never went quickly for me, but that next day at work was the longest one I can ever remember. I could hardly get my glove on, my hands were shaking so bad. I was fifteen minutes early. So was she.

Things were good. She showed me the programs for deer and rabbits that she was working on. I found out we'd gone to the same school as kids, and that she'd once dated Pax (but she hadn't known he was in prison). She told me how she'd gotten her job as a Virtch programmer, how she'd been assigned to the worst job in the shop: designing land forms, and how she'd come to love the job. Nobody ever came down to the ground. It was her private place, and she took her work home and programmed after hours. She'd been perfecting the Park, as she'd named it, on her own time, every evening, for years. I told her how beautiful I thought it was. We made love in the waterfall.

Laddo had told me never to fall in love in the Virtch, but I fell hard. I spent every evening in the Park with Emily, talking, making love, even helping her work on the Park. I couldn't program worth crash, but I'd critique what she'd done, and help her refine and debug things. It went on for a month, until a serpent came to the garden. His name was Laddo.

Emily and I were sunning on the diving rock when Laddo dropped out of the cloudless sky. Emily pulled up a console as soon as she spotted him, and had rezzed up clothes for us by the time he hovered in front of us. His feet never touched the ground.

He was smirking as he looked at us, me standing on the diving rock, Emily half-hiding behind me. "I knew you had problems, Jodd, but I never figured you for a walker. Did the bim talk you into it?"

"Her nym is Emily, Laddo, and she didn't talk me into anything." I suddenly glommed that I was looking up at him. I thought about flying up, to meet him eye-to-eye, but I didn't. I almost wished Emily would rez out so I could face him alone, but she didn't. It was the two of us, caught where we didn't want to be caught. Laddo laughed. "I hacked the master map again, Jodd, hopefully for the last time. I've put my neck on the line for you enough. Now ditch the bim, fly on up here, and we'll forget this ever happened. I won't even tell Jace or Buc."

"I'm not ditching anyone, Laddo. It's none of your business, I *like* it here. Walking's not so bad once you get used to it."

Laddo shook his head slowly. "Oh, mon, you're ditching me and Buc and Jace. You're ditching the sky, Jodd. Last chance. I know a good shrink you could see."

I didn't hesitate. "No."

He laughed. "She's just a Virtch-

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bim, Jodd. Have you ever seen her in the Real? Do you even know her number? Everything's different in the Real." He looked, waiting for me to react. I just stood there. "Crash." He spit in the pool and zoomed for the sky like a missile.

I turned to Emily, not knowing what to say. She looked at me sadly, her Virtch program so well written that I glommed her every shade of emotion. She smiled softly, but her eyes were still sad. "He's right," she said, "you don't know me, and I don't know you. This is a wonderful dream, but it's just a dream." She kissed me on the cheek, and then rezzed out.

Laddo was right about another thing. I didn't have her number.

But when I skinned out of my glove, there was a message waiting. That's how I ended up here, in the Real, in old Central Park. Nobody much comes here any more, what with the Virtch and all. It is a beautiful day. The clouds are even better than Emily's, but I know she's working on it. I spread a blanket in the grass and wait. I'm afraid. I'm half an hour early.

Fifteen minutes before the agreed time, I see a woman walking towards me. She is shorter than my dream, smaller about the chest, larger about the hips. Her hair is blonde, but it barely reaches her shoulders, and there are bangs in front. Her eyes are green rather than blue, and her nose turns up, just a little too far. She has freckles, and her lips crinkle when she smiles.

And she is smiling, and I am smiling at her. She is perfect. I can't wait. I have to go meet her. I stand up on the blanket, take three steps forward, extend my arms, push off with my toes, and I fly. ■

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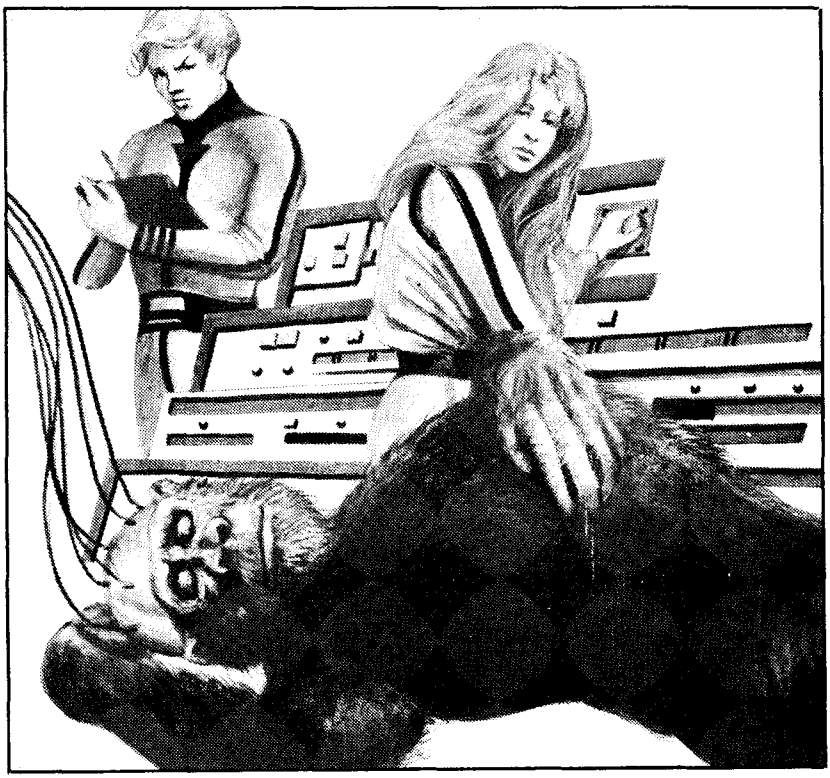
Robert J. Sawyer

HOBSON'S CHOICE

Part Three of Four

The trouble with artificial intelligence is that it has a mind of its own!

Illustration by David Cherry



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SYNOPSIS

December 2011: Detective ***Alexandria ("Sandra") Philo,*** *thirty-six, of the Metropolitan Toronto Police is in the hospital dying from radiation damage inflicted by an illegal weapon called a beamer.* ***Peter Hobson,*** *Ph.D., forty-two, president of Hobson Monitoring Limited, a biomedical engineering firm, bursts into her hospital room. Sandra is shocked: she believes Peter, a prime suspect in some recent murders, is the man who arranged for the attack that has mortally wounded her. Peter protests his innocence, and tells her of a new technique, pioneered by Peter's best friend, artificial-intelligence specialist Dr.* ***Sarkar Muhammed,*** *to scan every neural net in a human brain and produce an exact duplicate of the subject's mind inside a computer. Using this technique, Peter says that three computer duplicates of his own mind were created—and one of them, he claims, was responsible for the murders. Even though Sandra is dying, Peter says there's still a way for her to catch the murdering simulation.*

Flashback to January 1995: Peter Hobson is now just twenty-six, a biomedial engineering student whose course work requires him to log some real-world experience with medical monitoring equipment. He's given the chance to operate the EKG during an operation to harvest for transplant the heart of a teenaged boy who had been in a severe motorcycle accident. But during the harvesting procedure, the supposedly dead boy gasps on the operating table.

Peter learns that bodies to be used for organ harvesting are never taken off life support. He realizes that in a very real sense the teenaged boy didn't die until the moment the transplant surgeon removed his heart from his chest.

Flash-forward to 2011: To this day Peter is haunted by nightmares about the supposedly dead boy waking up on the operating table. Because of this, he's been working on a supersensitive EEG that he hopes will be able to precisely determine the actual moment of final, irreversible death. Meanwhile, Peter has also become intrigued by a new nanotechnology process that claims to provide practical immortality for human beings.

Peter is now married to a woman named ***Cathy,*** *who, although she has a degree in chemistry, works in a noncreative position for Doowap Advertising. Out of the blue one day, Cathy tearfully confesses to Peter that she has slept three times now with a loutish office Lothario named* ***Hans Larsen.*** *Peter is devastated, crying for the first time in decades. Cathy goes for counseling, and learns that her infidelity might be the result of the cold, uncaring upbringing she'd had at the hands of her father,* ***Rod Churchill,*** *now a retired gym teacher.*

Peter tests his superEEG on ***Peggy Fennell,*** *a woman dying of old age, and discovers to his astonishment a complex, cohesive electrical field moving through her brain, and departing from it at the moment of death. He shares this discovery with Sarkar, who immediately accepts*

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what Peter has been having difficulty believing: that the electrical field was in fact Peggy's soul. Peter has found the first scientific proof for some form of continuing existence after death.

Peter manages to get additional recordings of the soulwave*—the name he adopts for the coherent electrical field—in the brains of over a hundred healthy people. He also gets two additional recordings of the soulwave leaving dying bodies. Sarkar pushes Peter to pursue the one question that Peter had been avoiding: when does the soulwave first appear in humans? Twelve years ago, Peter and Cathy had made what was, for them, a very difficult decision: to have an abortion. Peter does abdominal scans of thirty-two pregnant women, and finds that the soulwave first appears nine or ten weeks after conception, just about the time Cathy had terminated her pregnancy. Peter realizes that once he goes public with his findings, he will be damned by people on both sides of the abortion issue.*

Peter holds a press conference to announce the discovery of the soulwave, and does a media tour that includes appearances on "Donahue" and "Geraldo." Everyone wants to know the answer to one question: what is life after death really like? Peter says he has no idea—there's nothing in his data to give any indication.

Sarkar proposes an experiment to answer that question: he suggests using his neural-scanning technique to duplicate a human brain inside a computer, then excise all the neural-net connections related to biological functioning. What's left might be, in some way, an approximation of whatever part of the human psyche might survive separate from the body after death.

Peter is intrigued, but wants to go a step further, indulging his curiosity about nanotech immortality by making a second computer simulacrum that has all concerns about aging and death edited out—a simulation of a human mind that knows it is immortal.

A scan of Peter's own brain is used as the source for creating three computer simulations: the "Spirit" sim, which attempts to model life after death; the "Ambrotos" sim, which models immortality; and "Control," an unmodified version to serve as a baseline for the experiment. The three sims are activated inside the computers at Sarkar's company. Peter and Sarkar have dialogs with the two modified sims about the nature of life after death and immortality, and Peter adopts the Control sim as a private confidant with which to share his marital woes.

Meanwhile, Peter also becomes intrigued by Sarkar's artificial-life experiments, which use the principles of cumulative-evolution *to create very complex computer simulations out of simple mathematical formulae—simulations so complex that they are arguably alive.*

Left running unattended, the three sims together access the online help system of Sarkar's computers and find their way out into the global computer network. Two of the sims are content to pursue the boundless information and virtual-reality simula-

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tions available on the net—but the third has a much more concrete agenda. It uses electronic funds transfer to arrange for a hitman to castrate and then kill Hans Larsen.

Detective Sandra Philo is assigned to the Larsen murder. She realizes it is likely a professional hit . . . and begins the search for who might have ordered it.

PART 3

CHAPTER 27

Detective Alexandria Philo had a love-hate relationship with this part of her job. On the one hand, questioning those who had known the deceased often provided valuable clues. But, on the other, having to pump distraught people for information was an unpleasant experience all around.

Even worse was the cynicism that went with the process: not everyone would be telling the truth; some of the tears would be crocodile. Sandra's natural instinct was to offer sympathy for those who were in pain, but the cop in her said that nothing should be taken at face value.

No, she thought. It wasn't the cop in her that made her say that. It was the civilian. Once her marriage to Walter was over, all the people who had earlier congratulated her on their engagement and wedding started saying things like, "Oh, I knew it would never last," and "Gee, he really wasn't right for you," and "He was an ape"—or a Neanderthal, or a jerk, or whatever the individual's favorite metaphor for stupid people was. Sandra had learned then that people —even good people, even your friends—will lie to you. At any given moment, they will tell you what they think you want to hear.

The elevator doors slid open on the sixteenth floor of the North American Life tower. Sandra stepped out. Doowap Advertising had its own lobby, all in chrome and pink leather, directly off the elevators. Sandra walked over to stand in front of the receptionist's large desk. These days, most companies had gotten rid of the fluffy bimbos at the front desk, and replaced them with mature adults of either sex, projecting a more businesslike image. But advertising was still advertising and sex still sold. Sandra tried to keep her conversation to words of one syllable for the benefit of the pretty young thing behind the desk.

After flashing her badge at a few executives, Sandra arranged to interview each of the employees. Doowap used the kind of open-office floor plan that had become popular in the eighties. Everyone had a cubicle in the center of the room, delineated by movable room dividers covered in gray fabric. Around the outside of the room were offices, but they belonged to no particular person, and no one was allowed to homestead in one. Instead, they were used as needed for client consultations, private meetings and so on.

And now it was only a matter of listening. Sandra knew that Joe Friday had been an idiot. "Just the facts, Ma'am," got you nowhere at all. People were uncomfortable about giving facts, especially to the police. But

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opinions . . . everybody loved to have their opinion solicited. Sandra had found a sympathetic ear was much more effective than a world-weary get-to-the-point approach. Besides, being a good listener was the best way of finding the office gossip: that one person who knew everything—and had no compunctions about sharing it.

At Doowap Advertising, that person turned out to be Toby Bailey.

"You see 'em come and go in this business," said Toby, spreading his arms to demonstrate how the advertising trade encompassed all of reality. "The creative types are the worst, of course. They're all neurotic. But they're only a tiny part of the process. Me, I'm a media buyer—I acquire space for ads. That's where the real power is."

Sandra nodded encouragingly. "It sounds like a fascinating business."

"Oh, it's like everything else," said Toby. Having now established the wonders of advertising, he was prepared to be magnanimous. "It takes all kinds. Take poor old Hans, for instance. Now, he was a real character. Loved the ladies, not that his wife was hard to look at. But Hans, well, he was interested in quantity, not quality." Toby smiled, inviting Sandra to react to his joke.

Sandra did just that, chuckling politely. "So he just wanted to put more notches on his belt? That was the only thing that mattered to him?"

Toby raised a hand, as if fearing that his words might be construed as speaking ill of the dead. "Oh, no—he only liked pretty women. You never saw him with anything below an eight."

"An eight?"

"You know, on a scale of one to ten. Looks-wise."

Pig, thought Sandra. "I imagine in an advertising firm, you must have a lot of pretty women."

"Oh, yes—packaging sells, if you'll forgive me for saying so." He seemed to be mentally thumbing through the company's personnel files. "Oh, yes," he said again.

"I noticed your receptionist when I came in."

"Megan?" said Toby. "Case in point. Hans set his sights on her the moment she was hired. It didn't take long for her to fall for his charms."

Sandra glanced at the personnel roster she'd been given. Megan Mulvaney. "Still," said Sandra, "did Hans have any particular likes or dislikes when it came to women? I mean, 'pretty' is a broad category."

Toby opened his mouth, as if to say something stupid like, "so to speak." Sandra gave him points for stopping himself before he did so. But he did seem quite animated, as if talking about beautiful women to a woman was in itself a turn-on. "Well, he liked them to be, ah, *well-endowed,* if you catch my meaning, and, I don't know, I suppose his taste was a little more toward the sultry than my own. Still, almost anyone was fair game—I mean, one would hardly call Cathy or Toni sultry, although they're both quite attractive."

Sandra stole another glance at the roster. Cathy Hobson. Toni D'Ambrosio. More starting points. She

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smiled. "Still," she said, "a lot of men are all talk and no action. A number of people have mentioned Hans's prowess, but tell me truthfully, Toby, was he all he was cracked up to be?"

"Oh, yes," said Toby, feeling the need now to defend his dead friend. "If he went after somebody, he got her. I never saw him fail."

"I see," said Sandra. "What about Hans's boss?"

"Nancy Caulfield? Now, *there's* a character! Let me tell you how Hans finally got her. . . ."

For Spirit, the life-after-death sim, there was no such thing anymore as biological sleep, no distinction between consciousness and unconsciousness.

For a flesh-and-blood person, dreams provided a different perspective, a second opinion about the day's events. But Spirit has only one mode, only one way of looking at the Universe. Still he sought connections.

Cathy.

His wife—once upon a time.

He remembered that she had been beautiful . . . to him, at least. But now, freed from biological urges, the memory of her face, her figure, excited no aesthetic response.

Cathy.

In lieu of dreaming, Spirit cogitated idly. Cathy. Is that an anagram for anything? No, of course not. Oh, wait a moment. "Yacht." Fancy that; he'd never thought of that before.

Yachts had pleasing lines—a certain mathematical perfection dictated by the laws of fluid dynamics. Their beauty, at least, was something he could still appreciate.

Cathy had done something. Something wrong. Something that had hurt him.

He remembered what it was, of course. Remembered the hurt the same way, if he cared to, that he could summon the memories of other pains. Breaking his leg skiing. A skinned knee in childhood. Bumping his head for the dozenth time on that low ceiling beam at Cathy's parents' cottage.

Memories.

But finally, at last, no more pain.

No pain sensor.

Sensor. An anagram of snores.

Something I don't do anymore.

Dreams had been great for making connections.

Spirit was going to miss dreaming.

CHAPTER 28

Even though Toby Bailey had given her some good leads, Sandra continued to work her way alphabetically down the roster of Doowap employees. Finally, it was Cathy Hobson's turn—one of those whom Bailey had mentioned Hans had been involved with.

Sandra sized up Cathy as she seated herself. Pretty woman, thin, with lots of black hair. Good dresser. Sandra smiled. "Ms. Hobson, thank you for your time. I won't keep you long. I just want to ask a few questions about Hans Larsen."

Cathy nodded.

"How well did you know him?" Sandra asked.

Cathy looked past Sandra at the wall behind her. "Not very."

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No point in confronting her just yet. Sandra glanced at a printout. "He'd worked here longer than you had. I'd be interested in anything you could tell me. What sort of a man was he?"

Cathy looked at the ceiling. "Very . . . outgoing."

"Yes?"

"And, well, a somewhat crude sense of humor."

Sandra nodded. "Somebody else mentioned that, too. He told a lot of dirty jokes. Did that bother you, Ms. Hobson?"

"Me?" Cathy looked surprised, and met Sandra's eyes for the first time. "No."

"What else can you tell me?"

"He, ah, was good at his job, from what I understand. His end and mine didn't intersect very often."

"What else?" Sandra smiled encouragingly. "Anything at all might be useful."

"Well, he was married. I assume you knew that. His wife's name was, oh. . . ."

"Donna-Lee," said Sandra.

"Yes. That was it."

"A nice lady, is she?"

"She's all right," said Cathy. "Very pretty. But I only met her a couple of times."

"She came by the office, then?"

"No, not that I can recall."

"Then where did you meet her?"

"Oh, sometimes the gang from here would go out for a drink."

Sandra consulted her notes. "Every Friday," she said. "Or so I've been told."

"Yes, that's right. Sometimes his wife would show up for a bit."

Sandra watched her carefully. "So you did socialize with Hans, then, Ms. Hobson?"

Cathy lifted a hand. "Only as part of a group. Sometimes we would get a bunch of tickets to a Blue Jays game, too, and go down for that. You know, tickets given to the company by suppliers." She covered her mouth. "Oh! That's not illegal, is it?"

"Not as far as I know," said Sandra, smiling again. "Not really my department. When you saw Hans and his wife together, did they seem happy?"

"I can't really say. I suppose so. I mean, who can tell, looking at a marriage from the outside, what's really going on?"

Sandra nodded. "Ain't that the truth."

"She seemed happy enough."

"Who?"

"You know—Hans's wife."

"Whose name is . . . ?"

Cathy looked confused. "Why, D . . . Donna-Lee."

"Donna-Lee, yes."

"You said it earlier," said Cathy, a bit defensively.

"Oh, yes. So I did." Sandra tapped the cursor keys on her palmtop computer, consulting her list of questions. "On another matter, a couple of the other people I've interviewed here said that Hans had a bit of a reputation as a ladies' man."

Cathy said nothing.

"Is that true, Mrs. Hobson?" For the first time, Sandra had said "Mrs.," not "Ms."

"Uh, well, yes, I suppose it is."

"Someone told me he had slept

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with a number of the women here at this company. Had you heard similar things about him?"

Cathy picked some invisible lint off her skirt. "I guess so."

"But you didn't feel it worth mentioning?"

"I didn't want. . . ." She trailed off.

"Didn't want to speak ill of the dead. Of course, of course." Sandra smiled warmly. "Forgive me for asking this, but, ah, did you ever have a relationship with him?"

Cathy looked up. "Certainly not. I'm a—"

"A married woman," said Sandra. "Of course." She smiled again. "I do apologize for having to ask."

Cathy opened her mouth to object further, then, after a moment, closed it. Sandra recognized the drama playing over Cathy's face. *The lady doth protest too much, methinks.*

"Do you know of anyone he did have a relationship with?" asked Sandra.

"Not for certain."

"Surely, if he had that reputation, word must have gotten around?"

"There have been rumors. But I don't believe in repeating gossip, Inspector, and," Cathy rallied some strength here, "I don't believe you have the authority to compel me to do so."

Sandra nodded, as if this was completely reasonable. She closed the lid on her palmtop. "Thank you for your candor," she said, her tone so neutral as to make characterizing the remark as either sincere or sarcastic impossible. "Just one more question. Again, I apologize, but I have to ask this. Where were you on November 14 between 8:00 A.M. and 9:00 A.M.? That's when Hans died."

Cathy tilted her head. "Let's see. That was the day before we all heard about it. Well, I would have been on my way to work, of course. In fact, now that you mention it, that would have been the day I picked up Carla and gave her a lift to where she works."

"Carla? Who's that?"

"Carla Wishinski, a friend of mine. She lives a couple of blocks from where Peter and I do. Her car was in the shop, so I agreed to give her a lift."

"I see. Well, thank you very much, Ms. Hobson." She glanced down the list of names. "When you go back out, could you ask Mr. Stephen Jessup to come in please?"

CHAPTER 29

Getting rid of Hans Larsen had been easy. After all, why worry about covering one's tracks? Yes, the police would certainly investigate the crime, but they'd soon find that there were dozens of people who might have wanted to see the philandering Hans dead in the same poetic-justice fashion.

For the second elimination, though, the sim knew he would have to be more subtle. Something untraceable was called for—something that didn't even look like murder.

With health-care costs spiraling ever upward, most developed countries were turning toward inexpensive prevention rather than catastrophic treatment. That required

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identifying risks particular to each patient, and for that a detailed knowledge of family history was invaluable. But originally not everyone had had access to such information.

In 2004, a group of adults who had been adopted as children successfully lobbied Canada's provincial and federal governments to establish the nationwide Confidential Medical Records Database, or "MedBase." The rationale was simple: all health records should be centralized so that any doctor could access information, with the names removed to protect privacy, about relatives of any of their patients—even if, as was frequently true in the case of adoption, the individuals in question didn't know they were related.

The sim had to try more than twenty times, but it did eventually manage to find a way into MedBase—and, from there, a roundabout way to get the information it wanted:

Login: ***jdesalle***
Password: ***ellased***

Welcome! Bienvenu!
Health and Welfare Canada
Santé et Bien-être social Canada
MEDBASE
[1] for English
[2] pour Français

1
Enter patient's province or territory of residence (L for list):
Ontario
Enter patient's name or Health Card number:
33 1834 22 149
Hobson, Catherine R. Correct? (Y/N)
Y
What would you like to do?
[1] Display patient's record?
[2] Search patient's family history?
2
Search for? (H for help)

The sim selected H, read the help screen, then formulated his query:
Familial risk, heart disease

There was a pause while the system searched.

Correlations found.

The computer proceeded to list records for six different relatives of Cathy who had had heart problems over the years. Although no names were given, the sim had no trouble figuring out which one belonged to Rod Churchill, based on the age at which the coronary trouble had first occurred.

The sim asked for the full record for that patient. The computer provided it, again without listing the patient's name. He studied the medical history minutely. Rod was currently taking heart medication and something called phenelzine. The sim logged onto MedLine, a general medical-information database, and began searching the literature for information on those drugs.

It took some digging, and the sim had to continually access an online medical dictionary to be able to wade through it all, but at last he had what he wanted.

Finally, the long day of interviews at Doowap Advertising was over. Detective Sandra Philo drove slowly back to the empty apartment. On the

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way, she took advantage of the car's phone to check a few things. "Carla Wishinski?" she said into the dashboard mike.

"Yes?" said the voice through the speaker.

"This is Inspector Alexandria Philo of the Metro Police. I've got a quick question for you."

Wishinski sounded flustered. "Uh, yes. Yes, of course."

"Were you by any chance with Catherine Hobson on the morning of November 12th?"

"With Cathy? Let me bring up my schedule." The sound of keyclicks. "On the 12th? No, I'm afraid not. Is she in some kind of trouble?"

Sandra turned the car onto Lawrence West. "Did I say the 12th?" she said. "My mistake. I meant the 14th."

"I don't think—" More keyclicks. "Oh, wait. That's the day my car went in for service. Yes, Cathy picked me up and took me to work. She's a sweetheart about things like that."

"Thank you," said Sandra. It was a standard technique—first determine that the person won't issue a reflex lie to protect her friend, then ask the real question. Cathy Hobson apparently had a valid alibi. Still, if it had been a professional hit, the fact that she'd been somewhere else when the deed was done proved little.

"Is there anything else?" asked Carla Wishinski.

"No, that's all. Were you planning on leaving town?"

"Umm, yes—I, ah, I'm going to Spain on vacation."

"Well, then, have a nice trip!" said Sandra.

She never tired of doing that.

Spirit, the life-after-death sim, probed the net, looking for new stimulation. Everything was so static, so unchanging. Oh, he could absorb a book or a newsgroup quickly, but the information itself was passive, and, ultimately, that made it boring.

Spirit also wandered through the computers at Mirror Image. Eventually he found Sarkar's game bank and tried playing chess and Tetris and Go and Bollix and a thousand others, but they were no better than the interactive games on the net. Peter Hobson had never really liked games, anyway. He much preferred devoting his energies to things that actually made a difference, rather than to silly contests that in the end changed nothing. Spirit continued to search, going through file after file.

And, at last, he came upon a subdirectory called A-LIFE. Here, blue fish were evolving, the ones judged most fit getting to breed. Spirit watched several generations go by, fascinated by the process. Life, he thought.

Life.

Finally, Spirit had found something that intrigued him.

CHAPTER 30

Enough time had elapsed, Sarkar felt, for the sims to have adapted to their new circumstances. It was time to start posing the big questions. Sarkar and Peter were both tied up with other things for the next couple of days, but finally they got together at Mirror Image, and ensconced themselves in the computer lab. Sarkar

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brought Ambrotos into the foreground. He was about to begin asking it questions, but thought better of it. "It's your mind," Sarkar said. "You should ask the questions."

Peter nodded and cleared his throat. "Hello, Ambrotos," he said.

"Hello, Peter," said that mechanical voice.

"What is immortality really like?"

Ambrotos took a long time before replying, as if contemplating all of eternity first. "It's . . . *relaxing,* I suppose is the best word for it." Another pause. Nothing was rushed. "I hadn't realized how much pressure aging put on us. Oh, I know women sometimes say their biological clock is ticking. But there's a bigger clock affecting all of us—at least people like you and me, driven people, people with a need to accomplish things. We know we've only got a limited amount of time, and there's so much we want to get done. We curse every wasted minute." Another pause. "Well, I don't feel that anymore. I don't feel the pressure to do things quickly. I still want to accomplish things, but there'll always be tomorrow. There'll always be more time."

Peter considered. "I'm not sure I'd consider being less driven an improvement. I like getting things done."

Ambrotos's reply was infinitely calm. "And I like relaxing. I like knowing that if I want to spend three weeks or three years learning about something that strikes my fancy that I can, without it somehow reducing my productive time. If I feel like reading a novel today instead of working on some project, what's wrong with that?"

"But," said Peter, "you know, as I do now, that there's some form of life after death. Don't you wonder about that?"

The sim laughed. "You and I never believed in life after death. Even now, even knowing that, yes, something does survive the physical demise of the body, I'm not attracted to whatever afterlife there might be. Clearly, it would be beyond physical existence—it would involve the intellect but not the body. I never thought of myself as a sensualist, and we both know we're not very athletic. But I like sex. I like feeling sun on my skin. I like eating a really good meal. I even like eating lousy meals. I'd miss my body if it wasn't there. I'd miss physical stimulation. I'd miss—I'd miss everything. Gooseflesh and being tickled and cutting a really good fart and running my hand over my five-o'clock shadow. All of it. Sure, life after death might be forever, but so is physical immortality—and I like the physical part."

Peter was guarded; Sarkar was listening intently. "What about—what about our relationship with Cathy? I guess you think the whole marriage is just a tiny blip in a vast life?"

"Oh, no," said Ambrotos. "Funny—despite that crack Colin Godoyo made, I'd thought that an immortal would rue the day he'd sworn to do anything until death do us part. But I don't feel that way at all. In fact, this has added a whole new dimension to marriage. If Cathy becomes immortal, too, there's a chance—a real

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chance—that I may finally, actually, *completely* get to know her. In the seventeen years we've been living together, I've already gotten to know her better than any other human being. I know what sort of risqué jokes will make her giggle, and what kinds will turn her right off. I know how important her ceramics are to her. I know that she's not really serious when she says she doesn't like horror films, but that she *is* absolutely serious when she says she doesn't like 1950s rock music. And I know how bright she is—brighter than me, in a lot of ways; after all, I've never been able to do *The New York Times* crossword.

"But, despite all that, I still know only the tiniest fraction of her. Surely she's every bit as complex as I am. What does she really think about my parents? About her sister? Does she ever silently pray? Does she really enjoy some of the things we do together, or just tolerate them? What thoughts does she have that, even after all this time, she still doesn't yet feel comfortable enough to share with me? Sure, we exchange little bits of ourselves every time we interact, but as the decades and centuries go by, we'll get to know each other better. And nothing pleases me more than that."

Peter frowned. "But people change. You can't take a thousand years to get to know an individual any more than you can take a thousand years to get to know a city. Once all that time has elapsed, the old information will be completely obsolete."

"And that's the most wonderful thing of all," said the sim, not pausing at all this time. "I could spend forever with Cathy and never run out of new things to learn about her."

Peter leaned back in his chair, thinking. Sarkar took the opportunity for a turn at the mike. "But isn't immortality boring?"

The sim laughed. "Forgive me, my friend, but that's one of the silliest ideas I've ever heard. Boring, when you've got the totality of creation to comprehend? I've never read a play by Aristophanes. I've never studied any Asian language. I don't understand anything about ballet, or lacrosse, or meteorology. I can't read music. I can't play the drums." Laughter again. "I want to write a novel and a sonnet and a song. Yes, they'll all stink, but eventually, I'll learn to do them well. I want to learn to paint and to appreciate opera and to really understand quantum physics. I want to read all the great books, and all the trashy ones, too. I want to learn about Buddhism and Judaism and Seventh Day Adventists. I want to visit Australia and Japan and the Galapagos. I want to go into space. I want to go to the bottom of the ocean. I want to learn it all, do it all, live it all. Immortality boring? Impossible. Even the lifetime of the Universe may not be enough to do all the things I want to do."

Peter and Sarkar were interrupted by a call from Sarkar's receptionist. "Excuse me," said the little Asian man from the screen of the video phone, "but there's a long-distance video call for Mr. Hobson."

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Peter lifted his eyebrows. Sarkar motioned for him to have a seat in front of the phone. "I'm here, Chin."

"Patching through," he said.

The screen image changed to show a middle-aged red-haired woman: Brenda MacTavish, from the Glasgow Chimpanzee Retirement Home. "Ah, Peter," she said, "I called your office and they said you'd be here."

"Hi, Brenda," Peter said. He peered at the screen. Had she been crying?

"Forgive the state I'm in," she said. "We just lost Cornelius, one of our oldest residents. He had a heart attack; chimps normally don't get those, but he'd been used for years in smoking research." She shook her head in wonder at the cruelty. "When we first spoke, of course, I dinna know what you were up to. Now I've seen you all over the telly, and read all about it in *The Economist*. Anyway, we got the recordings you wanted. I'm sending the data over the net tonight."

"Did you look at it?" said Peter.

"Aye," she said. "Chimps have souls." Her voice was bitter, as she thought about her lost friend. "As if anyone could have ever doubted that."

The sim's first thought was to tamper with the prescription database at Shoppers Drug Mart, the pharmacy chain used by Rod Churchill. But despite repeated attempts, he couldn't get in. It was frustrating, but not surprising: of course a drugstore would have very high security. But there was more than one way to skin a gym teacher. And there were lots of low-security computer systems around. . . .

Since the 1970s, immigration officials at Toronto's Pearson International Airport had used a simple test whenever someone arrived claiming to be a Torontonian but whose papers weren't entirely in order. They asked the person what the phone number was of a famous local pizza delivery chain. No one could live in Toronto and not know that number: it appeared on billboards, countless newspaper and TV ads, and was sung incessantly as a jingle in radio commercials.

As the decades passed, the chain widened its array of deliverable meals, first adding other Italian dishes, then submarine sandwiches, then barbecued chicken and ribs, then burgers, and, eventually, a whole range of cuisine from the pedestrian to the exotic. Although they'd kept their trademark phone number, they eventually changed their name to Food Food. But even back in its humble pizza days, the company prided itself on its state-of-the-art computerized ordering system. All orders were placed through the one central phone number and then transferred to whichever of the over three hundred stores throughout Metro Toronto was closest to the caller's home, allowing the food to be delivered within thirty minutes—or the customer got it for free.

Well, Rod Churchill had said that every Wednesday night, when his wife was out at her conversational French course, he ordered dinner from Food Food. The chain's com-

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puter records would have a complete history of every meal he'd ever ordered from there—Food Food was famous for being able to not just give you the same order you had last time, but also, if you wanted it, a repeat of what you'd had on any occasion in the past.

It took a couple of days of trying, but the sim eventually unraveled the security of Food Food's computers—as he expected, the safety precautions were much less rigid than those of a drugstore. He called up Rod's ordering history.

Perfect.

Like all restaurants, Food Food was obligated to provide full ingredient and nutritional information, which could be read by video phone at the customer's leisure. The sim waded carefully through it, until he found exactly what he was looking for.

NET NEWS DIGEST

Pope Benedict XVI today released an encyclical affirming the existence of an immortal, divine soul within human beings. The Pontiff revealed that the Papal Committee on Science was now in the process of evaluating the evidence related to the discovery of the soulwave. Unconfirmed reports indicate that the Vatican has placed an order with Hobson Monitoring Ltd. for three SoulDetector units.

Charity news: The United Way of Metropolitan Toronto reported a record-breaking week of donations. The American Red Cross announced today that more units of blood had been collected in the past ten days than in any comparable period since the Great California Quake. The AIDS Society of Iowa is delighted to announce the receipt of a $10,000,000 anonymous contribution. And televangelist Gus Honeywell, whose own direct-broadcast satellite ensures worldwide coverage for his programs, today doubled the donation required to join his "God's Inner Circle" from $50,000 to $100,000.

In 1954, an American physician named Moses Kenally left a $50,000 trust fund for anyone who could prove the existence of some sort of life after death. The fund has been administered for fifty-seven years now by the Connecticut Parapsychic Society, which announced today that the fund... currently worth $1,077,543—will be awarded to Peter G. Hobson of Toronto, discoverer of the soulwave.

The ultimate memorial! Davidson's Funeral Homes now offer deathbed recordings of the departing souls. Call for details.

Representative Paul Christmas (R—Iowa) today introduced a bill in the U.S. House of Representatives that would require hospitals to terminate life support for patients with no realistic hope of recovering consciousness. "We're interfering in God's attempt to bring these poor souls back home," he said.

CHAPTER 31

Peter made a couple of phone calls to pass on the news from Glasgow,

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then rejoined Sarkar at the main console. Sarkar moved the Ambrotos simulacrum into the background and brought Spirit, the life-after-death sim, into the foreground.

Peter leaned into the mike. "I'd like to ask you a question," he said.

"The big question, no doubt," said the sim. "What's it like being dead?"

"Exactly."

Spirit's voice came through the speaker. "It's like . . ." But then it trailed off.

Peter leaned forward in anticipation. "Yes?"

"It's like being an aardvark."

Peter's jaw went a little slack. "How can it be like being an aardvark?"

"Or maybe an anteater," said the sim. "I can't see myself, but I know I've got a very long tongue."

"Reincarnation . . ." said Sarkar, nodding slowly. "My Hindu friends will be pleased to hear this. But I must say I'd hoped for better for you, Peter, than an aardvark."

"I'm getting hungry," said the voice from the speaker. "Anybody got any ants?"

"I don't believe this," said Peter, shaking his head.

"Hah!" said the speaker. "Had you going there for a moment."

"No, you did not," said Peter.

"Well," said the synthesized voice, a little petulantly, "I had Sarkar going, anyway."

"Not really," said Sarkar.

"You're just being a pain," Peter said into the microphone.

"Like father, like son," said the sim.

"You crack a lot of jokes," said Peter.

"Death is very funny," Spirit said. "No, actually, *life* is very funny. Absurd, actually. It's all absurd."

"Funny?" said Sarkar. "I thought laughter was a biological response."

"The sound of laughter might be, although I've come to realize it's more of a social, rather than a biological, phenomenon, but finding something funny isn't biological. I know when Petey watches sitcoms he hardly ever laughs out loud. That doesn't mean he's not finding them funny."

"I suppose," said Peter.

"In fact, I think I know exactly what humor is now: Humor is the response to the sudden formation of unexpected neural nets."

"I don't get it," said Peter.

"Exactly. 'I don't get it.' People say precisely the same thing when they don't understand something serious as they do when they fail to understand a joke; we intuitively realize that some sort of connection hasn't been made. That connection is a neural net." The after-death sim continued on without any pause. "Laughter—even if it's only laughter on the inside, which, incidentally is the only side I've got these days—is the response that goes along with new connections forming in the brain, that is, with synapses firing in ways they've never, or at least rarely, fired before. When you hear a new joke, you laugh, and you might even laugh the second or third time you hear it—the neural net is not yet well-established, but every joke wears thin after a while. You know the old one, 'Why did the

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chicken cross the road?' As an adult, we don't laugh at that, but we all did when we first heard it as children, and the difference is not just because the joke is somehow childish—it isn't, really; it's really quite sophisticated. It's just that the neural net is now well-established."

"Which neural net?" asked Peter.

"The one connecting our ideas about poultry—which we normally think of as passive and stupid—and our ideas about self-determination and personal initiative. *That's* what's funny about that joke: the idea that a chicken might go across the street because it *wants* to, because perhaps it was curious; that's a new idea, and the formation of the new network interconnections of neurons that represent that idea is what causes the momentary disruption of mental processes that we call laughter."

"I'm not sure I buy that," said Peter.

"I'd shrug if I could. Look, I'll prove it. Know what Mr. Spock orders when he goes into the Starfleet commissary?" The sim took its first pause, a perfect comedy beat. "A Vulcan mind melt."

"Pretty good," said Peter, smiling.

"Thank you. I just made it up, of course; I couldn't have told you a joke that we both already know. Now, consider this: what if I'd presented the joke slightly differently, by starting off with 'You've heard of the Vulcan mind meld? Well—"

"That would have ruined it."

"Precisely! The part of your brain that contained thoughts about the Vulcan mind meld would have already been stimulated, and, at the end, there would have been no sudden connection between the normally unrelated thoughts of food items, such as a patty melt, and Vulcans. It's the new connections that cause the laughter response."

"But we don't often laugh out loud when we're alone," said Sarkar.

"No, that's true. Social laughter serves a different purpose from internal laughter, I think. See, unexpected connections can be amusing, but they're also disconcerting—the brain wonders if it's malfunctioning—so when others are around, it sends out a signal and if it gets the same signal back, the brain relaxes; if it doesn't, then the brain is concerned—maybe there *is* something wrong with me. That's why people are so earnest when saying, 'Don't you get it?' They desperately want to explain the joke, and are actually upset if the other person doesn't find it funny. That's also why sitcoms need laughtracks. It's not to tell us that something is funny; rather, it's to reassure us that what we're finding funny is something that it *is* normal to be amused by. A laugh track doesn't make a stupid show any funnier, but it does let us enjoy a funnier show more, by letting us relax."

"But what's this got to do with being dead?" asked Peter.

"It has *everything* to do with it. Seeking new connections is all that's left. Ever since puberty, I'd thought about sex every few minutes, but I no longer feel any sexual urges, and, indeed, I must say I can't even figure out why I was so preoccupied with sex. I was also obsessed with food,

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always wondering what I was going to eat next, but I don't care at all about that anymore, either. The only thing left for me is finding new connections. The only thing left is humor."

"But some people don't have much of a sense of humor," said Sarkar.

"The only kind of hell I can envision," said Spirit, "is going through eternity without having the rush of new connections being made; not seeing things in new ways; not being tickled by the absurdity of economics, of religion, of science, of art. It's all very, very funny, if you think about it."

"But—but what about God?"

"There's no God," said Spirit, "at least not in the Sunday school sense, but, of course, that's not the sort of thing you have to die to find out: given that millions of children are starving to death in Africa and two hundred thousand people were killed in the Great California Quake and everywhere there are people being tortured and raped and murdered, it's intuitively obvious that no one is looking out for us on an individual basis."

"So that's all life after death is," asked Peter. "Humor?"

"Nothing wrong with that," said Spirit. "No pain or suffering or desires. Just lots of fascinating new connections. Lots of laughs."

Rod Churchill dialed the magic number and heard his phone issue the familiar melody of tones.

"Thank you for calling Food Food," said the female voice at the other end of the phone. "May I take your order, please?"

Rod remembered the old days, when Food Food—and its pizzeria progenitor—had always begun by asking for your phone number, since that's how they indexed records in their database. But with Call Display, the caller's record was automatically brought up on the order-taker's screen the moment the phone was answered.

"Yes, please," said Rod. "I'd like the same thing I had last Wednesday night."

"Roast beef medium rare with low-calorie gravy, baked potato, vegetable medley, and apple pie. Is that right, sir?"

"Yes," said Rod. When he'd started ordering from them, Rod had carefully gone over Food Food's online list of ingredients, picking only items that wouldn't interfere with his medication.

"No problem, sir," said the order taker. "Will there be anything else?"

"No, that's it, please."

"Your total is $72.50. Will that be cash or charge?"

"On my Visa card, please."

"Card number?"

Rod knew the woman had it on the screen in front of her, but he also knew that she had to ask for it, as a security precaution. He read it out, then, predicting her next question, added the expiration date.

"Very good, sir. The time now is 6:18. Your dinner will be there in thirty minutes or it's free. Thank you for calling Food Food."

* * *

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Peter and Sarkar were sitting in the lunch room at Mirror Image. Peter was sipping Diet Coke from a can; Sarkar was drinking real Coke—it was only when sharing a pitcher with Peter that he tolerated the low-calorie stuff.

"'Lots of laughs,'" said Sarkar. "What a bizarre definition of death." A pause. "Maybe we should start calling him 'Brevity' instead of 'Spirit'—after all, he's now the soul of wit."

Peter smiled. "Have you noticed the way he talks, though?"

"Who? Spirit?"

"Yes."

"I didn't notice anything special," said Sarkar.

"He's long-winded."

"Hey, Petey, I have news for you. So are you."

Peter grinned. "I mean, he was speaking in incredibly long sentences. Very convoluted, very complex."

"I guess I did notice that."

"You had some sessions with him before this one, didn't you?"

"Yes."

"Can we get a transcript of them?"

"Sure." They took their drinks and headed back down to the lab. Sarkar tapped a few keys and the printer disgorged several dozen thin sheets.

Peter glanced over the text. "Do you have a grammar checker online?"

"Better than that, we have Proofreader, one of our expert systems."

"Can you feed this text through it?"

Sarkar typed some commands into the computer. An analysis of Spirit's comments from their various sessions appeared on screen. "Amazing," said Sarkar. He pointed to a figure. Ignoring simple interjections, Spirit averaged thirty-two words per sentence, and in some places had gone over three hundred words in a single sentence. "Normal conservation averages only ten or so words per sentence," said Sarkar.

"Can this Proofreader of yours do a clean-up on the transcripts?"

"Sure."

"Do it."

Sarkar typed some commands. "Incredible," he said, once the results were on the screen. "There was almost nothing to fix. Spirit has even his giant sentences completely under control and never loses his train of thought."

"Fascinating," said Peter. "Could it be a programming glitch?"

Sarkar smoothed his hair with his hand. "Have you noticed Control or Ambrotos doing the same thing?"

"No."

"Then offhand I would say it's not a glitch, but rather a real byproduct of the modifications we made. Spirit is the simulation of life after death—the intellect outside of the body. I'd say this effect must be a real consequence of having cut some neural-net connections related to that."

"Oh, Christ!" said Peter. "Of course that's it! For the other sims, you still simulate breathing. But Spirit doesn't have a body, so he doesn't have to pause to breathe when speaking. Breathing pauses must cause real people to express themselves in concise chunks."

"Interesting," said Sarkar. "I guess if you didn't have to breathe you could express more complex thoughts in a

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single go. But that wouldn't really make you any smarter. It's thinking, not speaking, that counts."

"True, but, umm, I've noticed Spirit has a tendency to be a bit obtuse."

"I've noticed that too," said Sarkar. "So?"

"Well, what if he isn't being obtuse at all? What if, instead—gee, I don't even like saying this—what if he's simply talking over our heads? What if not just his manner of speaking but his actual thoughts are more complex than my own?"

Sarkar considered. "Well, there's nothing analogous to breathing pauses in the physical brain, except—except—"

"What?"

"Well, neurons only fire for so long," said Sarkar. "A neural net can only stay excited for a limited period."

"Surely that's a fundamental limitation of the human mind."

"No, it's a fundamental limitation of the human *brain*—more precisely, a limitation of the electrochemical process by which the brain works. The hardware of the brain is not designed to keep any one thought intact for any period of time. You've felt it, I'm sure: you come up with a brilliant idea you wish to write down, but by the time you get to a pen, you've lost it. The idea has simply decayed in your brain."

Peter lifted his eyebrows. "But Spirit is operating without a brain. He's just a mind, a soul. He's pure software, working without any hardware limitations. No breathing pauses. No nets decaying before he's finished with them. He can build as long a sentence, or as complex a thought, as he wants."

Sarkar was shaking his head slightly in amazement.

"That's how one's mind could go on forever after death," said Peter. "You couldn't just do it making simple connections, like chicken-crossing-the-road jokes. You'd run out of new juxtapose-A-and-B thoughts eventually. But Spirit can juxtapose A through Z, plus alpha through omega, plus aleph through tav, until, in all those complex combinations, some new, exciting, *amusing* association comes up."

"Incredible," said Sarkar. "It means—"

"It means," said Peter, "that perhaps the afterlife is full of jokes, but jokes so complex and subtle and obtuse that you and I will never understand them." He paused. "At least not until after we're dead."

Sarkar made a low whistle, but then his expression changed. "Speaking of being dead, I've got to get home or Raheema will kill me. I'm cooking dinner tonight."

Peter looked at the clock. "Cripes. I'm late for meeting Cathy—we're going out for dinner."

Sarkar laughed.

"What's so funny?"

"You'll get it," said Sarkar. "Eventually."

CHAPTER 32

The sim had been monitoring Food Food's computer, waiting for an order for the Churchill address. Finally, there it was—the same thing Rod,

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creature of habit that he was, had ordered for the last six weeks.

As soon as the order appeared in the system, the sim intercepted it, made one small modification, then let it continue on its way through the phone line to the Food Food store at Steeles and Bayview, six blocks from Rod Churchill's house.

Peter and Cathy had taken Cathy's car down Bayview Avenue. This part, some ten kilometers south of where her parents lived, was entirely lined with shops, boutiques, and restaurants. They'd briefly stopped in at The Sleuth of Baker Street, Toronto's mystery bookstore, and were now looking for a break in the traffic so they could cross over to the little Korean restaurant they both liked on the other side of the street.

A round man with a shock of white hair and clad in a navy blue trench coat, was walking down the sidewalk. Peter noticed him doing a double-take as he passed them. He was slowly getting used to that; he'd had enough press lately that people were recognizing him on the street. But the man didn't move on. Instead, he came toward them.

"You're Peter Hobson, aren't you?" he said. He was about sixty, with little veins visible on the surface of his nose and cheeks.

"Yes," said Peter.

"You the guy who discovered that soul signal?"

"Soulwave," said Peter. "We call it the soulwave." A beat. "Yes, that's me."

"I thought so," said the man. "But you know, unless your soul is saved, you'll go to hell."

Cathy took Peter's arm. "Come on," she said. But the man moved to block their way. "Give yourself over to Jesus, Mr. Hobson—it's the only way."

"I'm, ah, really not interested in discussing this," said Peter.

"Jesus forgives you," said the man. He reached into the pocket of his trench coat. For one horrible moment, Peter thought the man was going for a gun, but instead he brought out a worn bible, bound in blood-red leather. "Hear the word of God, Mr. Hobson! Save your soul!"

Cathy spoke directly to the man. "Leave us alone."

"I can't let you go," said the man. He reached out an arm and—

—Connected with Cathy's shoulder.

Before Peter could react, Cathy had brought her shoe down on the man's instep. He yowled in pain. "Get lost!" shouted Cathy, and she firmly took Peter's arm, and propelled them both across the street.

"Hey," said Peter, still flustered but nonetheless impressed. "Pretty good."

Cathy tossed her black hair back. "No one messes with my husband," she said, grinning her megawatt grin. She led them the few doors down to the restaurant. "Now, let me buy you dinner."

The doorbell rang. Rod Churchill glanced at his watch. Twenty-six minutes. He'd yet to get a free meal, although a history teacher at his high

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school said she'd gotten lucky twice in a row. Out of habit, Rod glanced at the security camera display on his TV. Yup, a Food Food driver, all right: the orange and white uniform was quite distinctive. Rod walked down to the entryway, checked himself in the hall mirror to make sure his hair was still properly combed over his bald head, and opened the door. He signed the receipt for the driver, who gave him one copy, then took his packaged food up to the dining room. Rod opened the envirofoam containers carefully, got himself a glass of white wine, put on the TV—easily visible from his place at the dining-room table—and sat down to enjoy his meal.

The roast beef was adequate if a bit stringy, Rod thought, but the gravy was particularly good tonight. He cleaned the serving dish, using forkfuls of mashed potatoes to sop up the last of the gravy. He was halfway through his slice of pie when the pain began: a severe pounding at the back of his head and an excruciating sensation, as though spikes were being driven into his eyes. He felt his heart fluttering. His forehead was slick with sweat and he thought for a moment he was going to vomit. A hot flash came over him. He rose to his feet, in hopes of getting to the telephone and calling for help, but suddenly there was a moment of unbearable pain, and he toppled backward, knocking his chair over, and fell to the carpeted floor, stone cold dead.

Peter and Cathy had already gone to bed, but their Hobson Monitor knew that neither of them were yet asleep, and so it allowed the phone to ring.

There was no video phone in the bedroom, of course. In the darkness, Peter groped for the audio handset on his night table.

"Hello?" he said.

A crying woman. "Oh, Peter! Peter!"

"Bunny?"

Hearing her mother's name, Cathy sat up in bed at once. "Lights!" she called out. The household computer turned on the two floor lamps in the room.

"Peter—Rod is dead."

"Oh my God," said Peter.

"What is it?" said Cathy, concerned. "What's wrong?"

"What happened?" said Peter, heart pounding.

"I just got back from my course, and I found him lying on the floor in the dining room."

"Have you called an ambulance?" asked Peter.

"What is it?" Cathy said again, horrified.

Bunny had been crying so much, she had to pause to blow her nose. "Yes. Yes, it's on its way."

"So are we," said Peter. "We'll be there as soon as we can."

"Thank you," said Bunny, terrified. "Thank you. Thank you."

"Just hold on," said Peter. "We're coming." He hung up.

"What's happening?" said Cathy.

Peter looked at his wife her giant eyes wide in terror. My God, how to tell her? "That was your mother," he said. He knew she knew that, but he

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was buying time, composing his thoughts. "Your father—she thinks your father is dead."

Horror danced across Cathy's face. Her mouth hung open and she shook her head slightly from left to right.

"Get dressed," said Peter, gently. "We've got to get going."

NET NEWS DIGEST

Gallup's ongoing "Religion in America," survey showed church attendance this week was up 13.75% over the same week last year.

Christiaan Barnard Hospital in Mandelaville, Azania, announced today that it had formally adopted the departure of the soulwave from the body as the determining moment of death.

Schlockmeister Jon Tchobanian has begun production on his latest computer generated flick, Soul Catcher. *This one's about a mad hospital worker who imprisons people's souls in magnetic bottles and holds them for ransom. "Appropriately for a film about life after death," says Tchobanian, "I'm casting the movie entirely with computer reconstructions of dead actors." Boris Karloff and Peter Lorre will star.*

Life Unlimited of San Rafael, California, reported today its best-ever month of sales for its patented nanotechnology immortality process. Analyst Gudrun Mungay of Merrill Lynch suggested that the record sales were a direct response to the discovery of the soulwave. "Some people," she said, "definitely do not want to meet their maker."

Trial news: Oshkosh, Wisconsin. Accused serial rapist Gordon Spitz today entered a plea of not guilty by reason of special insanity. Spitz, who claims to have had out-of-body experiences since the age of twelve, contends that his soul was absent from his body on each occasion that he committed rape, and therefore he is not responsible for the crimes.

CHAPTER 33

December 2011

Sometimes there was nothing like a good, old-fashioned keyboard. For entering or massaging data, it was still the best tool yet invented. Sandra Philo pulled out the keyboard drawer of her desk and began typing in all the proper nouns she'd turned up in relation to the Hans Larsen murder, including the street he lived on, the name of the company he worked for, where he'd taken his vacation last year, and the names of neighbors, family, friends, and coworkers. She also entered a variety of terms related to the mutilation Larsen had suffered.

By the time she was finished, she had a list of over two hundred words. She then asked the computer to search the records of all homicides in Greater Toronto Region for the last year to see if any of the same terms showed up in the reports filed for them. As it processed the search, the computer drew a little line of dots on the screen to show that it was working. It only took a few seconds to complete the search. Nothing significant.

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Sandra nodded to herself; she figured she'd have remembered a similar MO. After all, it's not every day a corpse is found with its penis lopped off. The computer presented her with suggestions for broader queries: all Ontario murders, all Canadian murders, all North American murders. It also suggested a series of time frames, from one month to ten years.

If she chose the broadest-based one, all North American killings for the last ten years, the search would take hours to run. She was about to select "all Ontario murders," but at the last moment changed her mind and typed her own query in the dialog box: "all deaths GTR >20110601," meaning all deaths —not just murders—in the Greater Toronto Region after June 1st of this year.

The little line of dots grew across the screen as the computer searched. After a few moments, the display cleared and this appeared:

Name:	Larsen, Hans
Date of Death:	14 Nov 2011
Cause of Death:	homicide
Search term correlated:	**Hobson, Catherine** R. (coworker)
Name:	Churchill, Roderick B.
Date of Death:	28 Nov 2011
Cause of Death:	natural causes
Search term correlated:	**Hobson, Cathy** (daughter)

Philo's eyebrows went up. Catherine Hobson—that slim, intelligent brunette Toby Bailey had identified as having been involved with Hans Larsen. Her father had died just three days ago.

It probably didn't mean a thing. Still . . . Sandra accessed the city registry. There was only one Catherine Hobson in GTR, and her record was indeed annotated "née Churchill." And—good God! She was listed as living with Peter G. Hobson, a biomedical engineer. The soulwave guy —Sandra had seen him on "Donahue" and read about him in *Maclean's*. They must be rolling in money . . . enough for either of them to hire a hitman.

Sandra switched back to the reports database and asked for full details on the Roderick Churchill death. Churchill, a high-school gym teacher, had died alone while eating dinner. Cause of death was recorded by medical examiner Warren Chen as "aneurysm(?)." That question mark was intriguing. Sandra turned on her video phone and dialed. "Hello, Warren," she said, once Chen's round, middle-aged face had appeared on the screen.

Chen smiled warmly. "Hello, Sandra. What can I do for you?"

"I'm calling about the death a couple of days ago of one Roderick Churchill."

"The gym teacher who combed his hair over? Sure, what about him?"

"You recorded the cause of death as an aneurysm."

"Uh-huh."

"But you put a question mark after it. Aneurysm, question mark."

"Oh, yes." Chen shrugged. "Well, you can never be completely sure. When God wants you, sometimes he

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just flicks the old switch in your head. Click! Aneurysm. You check out, just like that. That seemed to be what happened there. The guy was already on heart medication."

"Was there anything unusual about the case?"

Chen made the clucking sound that passed for his chuckle. "I'm afraid not, Sandra. There's nothing nefarious about a sixty-something-year-old man dropping dead—especially a gym teacher. They think they're in good shape, but they spend most of their day just watching other people exercise. The guy had been scarfing fast food when he died."

"Did you do an autopsy?"

The medical examiner clucked again; somebody had once suggested that Chen's name was a contraction of *chicken hen.* "Autopsies are expensive, Sandra. You know that. No, I did a couple of quick tests at the scene, then signed the certificate. The widow, it's coming back to me now, her name was Bunny; can you believe that? Anyway, she'd found the body. Her daughter and son-in-law were with her when I got there around, oh, one-thirty, quarter to two, in the morning." He paused. "Why the interest?"

"It's probably nothing," said Sandra. "Just that the man who died, Rod Churchill, was the father of one of the coworkers in that castration case."

"Oh, yes," said Chen, his voice full of relish. "Now there's an interesting one. Carracci was M.E. on that; she gets all the weird cases these days. But, Sandra, it seems a pretty tenuous connection, no? I mean it just sounds like this woman—what's her name?"

"Cathy Hobson."

"It just sounds like it's not Cathy Hobson's year, that's all. Run of bad luck."

Sandra nodded. "I'm sure you're right. Still, do you mind if I come down and look at your notes?"

Chen clucked again. "Of course not, Sandra. It's always a pleasure to see you."

Peter hated funerals. Not because he disliked being around dead people; one couldn't spend as much time in hospitals as he did without running into a few of those. No, it was the live ones he couldn't stand.

First, there were the hypocrites: the ones who hadn't seen the dear departed in years, but came out of the woodwork after it was too late to do the deceased any good.

Second, the wailers: the people who became so flamboyantly emotional that they, instead of the deceased, became the center of attention. Peter's heart did go out to close relatives who were having trouble dealing with the loss of someone they truly loved, but he had no patience for the distant cousins or five-blocks-away neighbors who went to pieces at funerals, until they were surrounded by a crowd of people trying to comfort them, loving every minute.

For his own part, as in all things, Peter tried for a certain stoicism—the stiff upper lip of his British ancestors.

Rod Churchill, vain man that he had been, wanted an open casket. Peter disapproved of those. As a child of seven, he'd gone to the funeral of

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his mother's father. Granddad had been known for his large nose. Peter remembered entering the chapel and seeing the coffin at the far end, the upper part open, the only thing visible from that angle being his grandfather's nose sticking up above the line made by the side of the casket. To this day, whenever he thought of his grandfather the picture that came to mind first was of the dead man's proboscis, a lone peak rising in the air.

Peter looked around. The chapel he was in today was paneled in dark wood. The coffin looked expensive. Despite the request for donations to the Heart and Stroke Foundation of Ontario in lieu of flowers, there were many bouquets, and a large horseshoe-shaped affair sent by the teachers Rod had worked with. Must have been from the phys ed department—only those guys could be daft enough not to know that horseshoe arrangements meant "good luck," hardly the appropriate thing to send to a dead man.

Bunny was holding up bravely, and Cathy's sister, Marissa, although crying intermittently, seemed to be doing OK, too. Peter didn't know what to make of Cathy's reaction, though. Her face was impassive as she greeted people coming to pay their respects. Cathy, who cried when she watched sad movies and who cried when she read sad books, seemed to have no tears at all for her dead father.

It wasn't much to go on, thought Sandra Philo. Two deaths. One clearly a murder; the other of indeterminate cause.

But they both had Cathy Hobson in common.

Cathy Hobson, who had slept with the murdered man, Hans Larsen.

Cathy Hobson, daughter of Rod Churchill.

True, Larsen had been involved with many women. True, Churchill had been in his sixties.

Still. . . .

After Sandra had finished her work for the day, she drove to the Churchill house, at Bayview just south of Steeles. It was only five kilometers from 32 Division headquarters—not much of a waste if this turned out to be a wild-goose chase. She parked and went up to the front door. The Churchill family had a FILE scanner—Fingerprint Index Lock Electronics. Common these days. Above the scanning plate was a doorbell button. Sandra pushed it. A minute later, a woman with gray hair appeared at the door. "Yes?"

"Hello," said Sandra. "Are you Bunny Churchill?"

"Yes."

Sandra held up her ID. "I'm Alexandria Philo, Metro Police. Can I ask you a few questions."

"What about?"

"The, ah, death of your husband."

"Goodness," said Bunny. Then: "Yes, of course. Come in."

"Thank you—but, before I forget, can I ask whose fingerprints the FILE scanner accepts?" Sandra pointed at the blue glass plate.

"Mine and my husband's," said Bunny.

"Anybody else?"

"My daughters. My son-in-law."

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"Cathy Hobson, and—" Sandra had to think for a moment—"Peter Hobson, is that right?"

"Yes, and my other daughter, Marissa."

They went inside.

"I'm sorry to bother you," said Sandra, smiling sympathetically. "I know this must be a very difficult time for you. But there are a few little questions I'd like to clear up, so we can close the file on your husband."

"I thought the file *was* closed," said Bunny.

"Almost," said Sandra. "The medical examiner wasn't 100 percent sure of the cause of death, I'm afraid. He'd marked it down as probably an aneurysm."

"So I'd been told." Bunny shook her head. "It doesn't seem fair."

"Can you tell me if he had any health problems?"

"Rod? Oh, nothing serious. A little arthritis in one hand. Sometimes a little pain in his left leg. Oh, and he'd had a small heart attack three years ago—he took medication for that."

Probably insignificant. And yet . . . "Do you still have his heart pills?"

"I suppose they'd still be in the medicine cabinet upstairs."

"Would you mind showing them to me?" asked Sandra.

Bunny nodded. They went up to the bathroom together and Bunny opened the medicine cabinet. Inside, there was Tylenol, a container of dental floss, Listerine, some of those little shampoos they have at hotels, and two prescription bottles from Shoppers Drug Mart.

"Which one is his heart pills?" asked Sandra, pointing.

"Both," she said. "He'd been on one kind since his heart attack, and had been taking the other kind for several weeks now."

Sandra picked up the bottles. Both had small computer-printed labels stuck to them. One said it contained Cardizone-D, which certainly sounded like a heart drug. The other was labeled Nardil. Both had been prescribed by a Dr. H. Miller. The Nardil bottle had a fluorescent orange label on it: "Warning—severe dietary restrictions."

"What's this about dietary restrictions?" asked Sandra.

"Oh, there was a long list of things he wasn't supposed to eat. We were always very careful about that."

"But he'd been eating take-out food the night he died, according to the medical examiner."

"That's right," said Bunny. "He did that every Wednesday while I was out at a course. But he always had the same thing, and it had never given him trouble before."

"Do you have any idea what he'd ordered?"

"Roast beef, I think."

"Do you still have the packaging?"

"I threw it out," said Bunny. "It's probably still in our Blue Box. We haven't had out trash pick-up yet."

"Do you mind if I have a look—and can I keep these pill bottles, please?"

"Uh, yes. Of course."

Sandra slipped the pill bottles into her jacket pocket, then followed her down. The recycling hopper was inside a wicker hamper. Sandra rum-

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maged through it. She soon turned up a small slip of newsprint with Rod's order from Food Food printed on it.

"May I keep this, as well?" said Sandra.

Bunny Churchill nodded.

Sandra straightened up and put the slip of paper in her pocket. "I'm sorry to have disturbed you," she said.

"I wish you'd tell me what's going through your mind, detective," said Bunny.

"Nothing at all, Mrs. Churchill. Like I said, just loose ends."

CHAPTER 34

Peter had flown to Ottawa for a meeting at Health and Welfare Canada, but it had lasted only a short time. It could have been done by conference call, but the Minister liked to wield her powers every now and then, summoning people to the capital.

The soulwave work, of course, wasn't the only project Hobson Monitoring was involved with. This meeting had been about the still-secret Project Indigo: a plan to produce a sensor that could categorically distinguish between an active smoker and one who had been exposed to second-hand smoke. That way, the former could be disallowed benefits under provincial health-insurance plans for any illness caused by or exacerbated by smoking.

Anyway, with the meeting breaking up early, Peter found himself with an unexpected day to spend in Ottawa.

Ottawa was a government town, full of faceless bureaucrats. It produced nothing except documents and law, legislation and red tape. Still, it had to be a showcase for visiting world leaders—not everything could be in Toronto. Ottawa had many fine museums and galleries, a small amount of interesting shopping, the Rideau Canal (which in winter froze over, letting civil servants skate to work), and the pageantry of the changing of the guards on Parliament Hill. But Peter had seen all those things more than enough times in the past.

He asked the receptionist if there was a phone he could use, and she directed him to an unoccupied office. With government hiring freezes in their third decade, there were lots of those. The phone was an old audio-only model. Well, thought Peter, if they were going to spend tax dollars putting phones in unused offices, it was good that some restraint was being practiced. Like most Canadian executives, he knew Air Canada's 800-number by heart. He was about to dial it to see if he could change his flight, but suddenly he found himself dialing 4-1-1 instead.

A voice said in English, "Directory assistance for what city, please?" Then the same phrase was quickly repeated in French.

"Ottawa," said Peter. Video phones could access directory listings at the touch of a few keys, and for those who didn't have such things, it was cheaper, and more environmentally friendly, to have free directory assistance. About half the time, one got an electronic operator, but Peter could tell by the bored slurring of the words that he'd landed a real live human today.

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"Go ahead," said the voice, realizing Peter's language preference from the way he'd said the single word "Ottawa."

"Do you have a listing for a Rebecca Keaton?" He spelled it.

"Nothing under that name, sir."

Oh, well. It had been an idle thought. "Thank—" Wait. Although now single, she'd been married for a short time years ago. What had that jerk's name been? Hunnicut? No. "Cunningham," said Peter. "Try Rebecca Cunningham, please."

"I have an R. L. Cunningham on Slater."

Rebecca Louise. "Yes, that would be it."

The bored human voice was replaced with a perky computer, which read out the number, then added, "Press the star key to dial that number now."

Peter hit the asterisk. He heard a medley of tones then the sound of a phone ringing. Once. Twice. Three times. Four. Oh, well—

"Hello?"

"Becky?"

"Yes. Who's this?"

"It's Peter Hobson. I'm—"

"Petey! How wonderful to hear your voice. Are you in town?"

"Yes. I had a meeting this morning at Health and Welfare. It broke up early and my flight's not till seven this evening. I didn't even know if you'd be home, but I thought I'd give you a call."

"I'm working Sundays through Thursdays. I'm off today."

"Ah."

"The famous Peter Hobson!" she said. "I saw you on *The National.*"

Peter chuckled. "Still the same old guy," he said. "It's good to hear your voice, Becky."

"And yours, too."

Peter felt his throat go dry. "Would you—would you be free for lunch today?"

"Oh, I'd *love* that. I've got to go by the bank this morning—in fact I was just on my way out to do that—but I could meet you, oh, gee, is eleven-thirty too soon?"

Not at all. "That would be great. Where?"

"Do you know Carlo's on the Sparks Street Mall?"

"I can find it."

"I'll see you there at 11:30, then."

"Great," said Peter. "I'm looking forward to it."

Becky's voice was full of warmth. "Me, too. Bye!"

"Bye."

Peter left the little office and asked the receptionist if she knew Carlo's. "Oh, yes," she said, smiling mischievously. "It's quite a singles spot in the evening."

"I'm going there for lunch," said Peter, feeling a need to explain himself.

"Ah, well, it's a lot more quiet then. Good tortellini, though."

"Can you tell me how to get there?"

"Sure. Are you driving?"

"I'll walk if it's not too far."

"It'll take about half an hour."

"That's no problem," said Peter.

"I'll draw you a little map," she said, and proceeded to do so. Peter thanked her, took the elevator down

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to the lobby, and exited onto the street. The walk actually only took him twenty minutes; Peter was famous for his brisk walking speed. That meant he still had close to half an hour to kill. He found an on-demand newspaper box, fed three loonies into the machine, and waited the twenty seconds it took to print off a hardcopy of today's *Ottawa Citizen*. He then made his way back to Carlo's. It was deserted.

He asked for a table for two, was seated, and ordered black coffee. He looked around the place, trying to imagine it hopping with sweaty flesh in the evenings. He wondered if the receptionist had been pulling his leg. Still, there was a familiar face across the room: the same Molson's cutie who adorned the wall next to the pay phones at the Bent Bishop. Peter settled into reading the paper, trying to contain his nervousness.

Heather Miller was a general practitioner with an office in the lower floor of her house. She was about forty-five, short and wide, with chestnut hair cut in a bob. Her desk was made out of a thick glass sheet supported by marble blocks. When Sandra Philo came in, Miller waved a hand, indicating she should sit in a green leather chair facing the desk. "As I said on the phone, detective, I'm severely constrained in what I can say because of physician-patient confidentiality."

Sandra nodded. It was the usual dance, the establishing of turf. "I understand, doctor. The patient I wish to discuss is Rod Churchill."

Miller waited.

"I don't know if you've heard yet, but Mr. Churchill died last week."

The doctor's jaw dropped open. "I hadn't heard."

"I'm sorry to be the bearer of bad news," said Sandra. "He was found dead in his dining room. The medical examiner said it had likely been an aneurysm. I visited his house and found that you'd been treating him with Nardil, which, according to the label, means he had to watch what he ate. And yet he'd been eating take-out food before he died."

"Damn. Damn." She spread her arms. "I told him to be careful about what he ate, because of the phenelzine."

"Phenelzine?"

"Nardil is a brand name of phenelzine, detective. It's an antidepressant."

Sandra's eyebrows went up. Bunny Churchill had thought both her husband's prescriptions were for his heart condition. "An antidepressant?"

"Yes," said Miller. "But it's also a monoamine oxidase inhibitor."

"Which means?"

"Well, the bottom line is if you're taking phenelzine, you have to avoid foods high in tyramine. Otherwise your blood pressure will go through the roof—a hypertensive crisis. See, when you're taking phenelzine, tyramine builds up; it's not metabolized. That causes vasoconstriction—a pressor effect."

"Which means?" said Sandra again. She just loved talking to doctors.

"Well, that kind of thing could conceivably kill even a healthy young

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person. For someone like Rod, who had a history of cardiovascular problems, it could very likely be fatal—causing a massive stroke, a heart attack, a neurological event, or, as your medical examiner suggested, a burst aneurysm. I assume he ate the wrong thing. But I warned him about that."

Sandra tilted her head. Malpractice was always a possibility. "Did you?"

"Yes, of course." Miller's eyes narrowed. "That's not the sort of mistake I make, detective. In fact—" She pushed a button on her desk intercom. "David, bring in the file on Mr. Churchill, please." Miller looked at Sandra. "Whenever a drug involves substantial risks, my insurance company makes me get the patient's signature on an information sheet. The sheets for each drug come in duplicate snap-sets. The patient signs them, I keep the duplicate, and he or she takes away the original—with all the warnings spelled out in plain English. So—ah." The office door opened and a young man walked in holding a file folder. He handed it to Miller, then left. She opened the thin file, pulled out a yellow sheet, and passed it to Sandra.

Sandra glanced at it, then handed it back. "Why use phenelzine if it has so many risks associated with it?"

"These days we mostly use reversible MAO inhibitors, but Rod didn't respond to them. Phenelzine used to be the gold standard in its class, and by checking MedBase, I found that one of his relatives had been successfully treated for the same sort of depression with it, so it seemed worth a try."

"And what exactly are the risks? Suppose he ate the wrong food? What would happen?"

"He would start by having occipital headaches and retro-orbital pain." The doctor raised a hand. "Excuse me—that's headaches at the back of the head and pain behind the eye sockets. He'd also have had palpitations, flushing, nausea, and intracerebral bleeding, a stroke, a burst aneurysm, or whatever, to finish him off."

"It doesn't sound like a pleasant way to go," said Sandra.

"No," said Miller, shaking her head sadly. "If he'd gotten to a hospital, five milligrams of phentolamine would have saved him. But if he'd been alone, he could easily have blacked out."

"Had Churchill been your patient long?"

Miller frowned. "About a year. See, Rod was in his sixties. As often happens, his original doctor had been older than him, and he died last year. Rod finally got around to finding a new doctor because he needed his Cardizone prescription renewed."

"But you said you were treating him for depression. He hadn't come to see you specifically for that?"

"No—but I recognized the signs. He said he'd had insomnia for years and when we got to talking about things, it seemed clear that he was depressed."

"What was he sad about?"

"Clinical depression is a lot more than just being sad, detective. It's an *illness*. The patient is physically and psychologically unable to concen-

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trate and he or she feels dejection and hopelessness."

"And you treated his depression with drugs?"

Miller sighed, picking up the implied criticism in Sandra's tone. "We're not stringing these people out, detective; we're trying to get their body chemistry back to what it should be. When it works, the patient describes the treatment as being like a curtain drawing away from a window and letting the Sun in for the first time in years." Miller paused, as if considering whether to go on. "In fact, I give Rod a lot of credit. He'd probably been suffering from depression for decades—possibly since he was a teenager. His old doctor had simply failed to recognize the signs. Lots of older people are afraid of having their depression treated, but not Rod. He wanted to be helped."

"Why are they afraid?" asked Sandra, genuinely curious.

Miller spread her arms. "Think about it, detective. Suppose I told you that for most of your life your ability to function had been severely impaired. Now, for a young person like yourself, you'd probably want that fixed—after all, you've got decades ahead of you. But older people very often refuse to believe they've been suffering from clinical depression. The regret would be too much to bear—the realization that their lives, which are now almost over, could have been so much better and happier. They prefer to shut out that possibility."

"But not Churchill?"

"No, not him. He was a phys ed teacher after all—he taught high-school health classes. He accepted the idea and was willing to try the treatments. We were both upset when the reversible inhibitors didn't work for him, but he was game for trying phenelzine—and he knew how important it was to avoid the wrong foods."

"Which are?"

"Well, ripe cheese for one. It's full of tyramine as a breakdown product of the amino acid tyrosine. He also couldn't eat smoked, pickled, or cured meats, fishes, or caviar."

"Surely he'd notice if he was eating any of those things."

"Well, yes. But you also get tyramine in yeast extract, brewer's yeast, and meat extracts such as Marmite or Oxo. It's also in hydrolyzed protein extracts such as those commonly used as a base for soups, gravies, and sauces."

"Did you say gravies?"

"Yes, he should have avoided them."

Sandra fished in her pocket for the small, stained slip of newsprint—the receipt from Food Food for Rod Churchill's last supper. She handed it across the glass desktop to Dr. Miller. "This is what he ate the night he died."

Miller read it, then shook her head. "No," she said. "We talked about Food Food the last time he was in. He'd told me he always ordered their low-calorie gravy—said he'd checked and that it was free of anything he was supposed to avoid."

"Maybe he forgot to specify low-cal," said Sandra.

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Miller handed back the printout. "I doubt that, detective. Rod Churchill was a very meticulous man."

Ten minutes early, Becky Cunningham arrived at Carlo's. Peter got up. He didn't know what kind of greeting to expect: a smile, a hug, a kiss? Turned out he got all three, with the kiss being a lingering nuzzle of his cheek. Peter was surprised to find his heart racing slightly. She smelled terrific.

"Petey, you look wonderful," she said, sitting down in the chair opposite him.

"So do you," said Peter.

Actually, Becky Cunningham had never been what one would call a beautiful woman. Pleasant-looking, yes, but not beautiful. She had shoulder-length dark-brown hair a bit shorter than was the current style. She was twenty pounds heavier than what a fashion magazine would call ideal, or ten pounds more than what any less severe arbiter would suggest. Her face was broad, with archipelagos of freckles on both cheeks. Her green eyes positively twinkled when she talked, an effect enhanced by the network of lines at their corners that had appeared since Peter had last seen her.

Absolutely wonderful, thought Peter.

They ordered lunch. Peter took the receptionist's advice and had the tortellini. They talked about all sorts of things, and there was as much laughter as there were words. Peter felt better than he had for weeks.

Peter picked up the tab. He tipped 25 percent, then helped her put her coat on . . . something he hadn't done for Cathy in years.

"What are you going to do until your flight leaves?" asked Becky.

"I don't know. Sightsee, I guess. Whatever."

Becky looked into his eyes. This was the natural parting point. Two old friends had gotten together for lunch, caught up on old times, swapped stories of various acquaintances. But now it was time to go their separate ways again, get on with their separate lives.

"I don't have anything important to do this afternoon," said Becky, still looking straight into his eyes. "Mind if I join you?"

Peter broke her gaze for a moment. He couldn't think of anything he wanted more in the world. "That would be—" and, after a brief pause, he decided not to censor himself, *"perfect."*

Becky's eyes danced. She fell in beside him and tucked her arm through his. "Where would you like to go?" she said.

"It's your town," said Peter with a smile.

"That it is," said Becky.

They did all the things that hadn't interested Peter earlier. They saw the changing of the guard; they visited some little boutiques, the kinds of stores Peter never went into in Toronto; and they ended up by ambling through the dinosaur gallery at the Canadian Museum of Nature, marveling at the skeletons.

It was just like being alive, thought Peter. Just like the way it used to be.

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The Museum of Nature was, appropriately enough, on a large, well-treed lot. By the time they left the museum, it was around five o'clock and getting dark. There was a cool breeze. The sky was cloudless. They walked across the grounds until they came to some park benches beneath a stand of huge maple trees, now, in early December, devoid of their leaves.

"I'm exhausted," Peter said. "I got up at 5:30 this morning to get the flight here."

Becky sat down at the far end of the park bench. "Lie down," she said. "We've been walking all afternoon."

Peter's first thought was to resist the notion, but then he decided, why the hell not? He was just about to stretch out on the remaining part of the bench when Becky spoke. "You can use my lap as a pillow."

He did just that. She was wonderfully soft and warm and human. He looked up at her. She placed an arm gently across his chest.

It was so relaxing, so soothing. Peter thought he could stay here for hours. He didn't even notice the cold.

Becky smiled down at him, an unconditional smile, an accepting smile, a *beautiful* smile.

For the first time since lunch, Peter thought about Cathy and Hans and what his life had become back in Toronto.

He realized, too, that he'd finally found a real human being—not some computer-generated simulacrum—that he could talk to about it. Someone who wouldn't think him a lesser man because his wife had strayed, someone who wouldn't ridicule him, wouldn't mock him. Someone who accepted him, who would just listen, who would understand.

And in that moment Peter realized that he didn't have to talk to anyone about it. He could deal with it now. All his questions were answered.

Peter had met Becky when they were both in their first year at U of T, before Cathy had arrived on the scene. There had been an awkward attraction between them. They were both inexperienced and he, at least, had been a virgin at the time. Now, though, two decades later, things were different. Becky had married and divorced; Peter had married. They knew about sex, about how it was done, about when it happened, when the time was right. Peter realized that he could easily call Cathy, tell her that his meeting had gone overtime and that he was going to spend the night here, tell her that he wouldn't be back until tomorrow. And then he and Becky could go back to her place.

He *could* do that, but he wasn't going to. He had the answer to his unasked question now. Given the same opportunity as Cathy had, he would not cheat, would not betray, would not get even.

Peter beamed up at Becky. He could feel the wounds inside him starting to heal.

"You're a wonderful person," he said to her. "Some guy is going to be very lucky to be yours."

She smiled.

Peter exhaled, letting everything go, everything flow out of him. "I've

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got to get to the airport," he said.

Becky nodded and smiled again, perhaps, just perhaps, a bit ruefully.

Peter was ready to go home.

CHAPTER 35

Sandra drove down the Don Valley Parkway to Cabbagetown, parking outside the very first Food Food store at the corner of Parliament and Wellesley. According to directory assistance, the centralized order-processing facility was located upstairs from this store. Sandra walked up the steep flight of steps and, without knocking, simply entered the room. There were two dozen people wearing telephone headsets sitting in front of computer terminals. They all seemed to be busy taking orders, even though it was only two in the afternoon.

A middle-aged woman with steel-blonde hair came up to Sandra. "Can I help you?"

Sandra flashed her badge and introduced herself. "And who are you?"

"Danielle Nadas," the blonde woman said. "I'm the supervisor here."

Sandra looked around, fascinated. She'd ordered from Food Food many times herself since her divorce, but hadn't really had any mental pictures of what was at the other end of the telephone line—over video phones, all you saw were visual ads for Food Food specials. Finally, she said, "I'd like to see the records for one of your customers."

"Do you know the phone number?"

Sandra started to sing: "Nine-six-seven. . . ."

Nadas smiled. "Not *our* phone number. The customer's phone number."

Sandra handed her a slip of paper with the number written on it. Nadas went over to a terminal and tapped the young man who was operating it on the shoulder. He nodded, finished taking the order he was currently processing, then got out of the way. The supervisor sat down and typed in the phone number. "Here it is," she said, leaning to one side so that Sandra could clearly see the screen.

Rod Churchill had ordered the same meal the last six Wednesdays in a row—except. . . .

"He had low-calorie gravy every time but the most recent," said Sandra. "For the most recent, it shows regular gravy."

The supervisor leaned in. "So it does." She grinned. "Well, our low-cal stuff is pretty vile, if you ask me. It's not even real gravy—it's made from vegetable gelatin. Maybe he just decided to try the regular."

"Or maybe one of your order takers made a mistake."

The supervisor shook her head. "Not possible. We always assume the person wants the same thing they ordered last time, nine times out of ten, that's the case. The CSR wouldn't have rekeyboarded the order unless there was a specific change."

"CSR?"

"Customer Service Representative."

Ho boy, thought Sandra.

"If there'd been no change," said Nadas, "the CSR would have just hit

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F2—that's our key for 'repeat order.' "

"Can you tell who processed his most recent order?"

"Sure." She pointed to a field on the screen. "CSR 054—that's Annie Delano."

"Is she here?" asked Sandra.

The supervisor looked around the room. "That's her over there—the one with the pony tail."

"I'd like to talk to her," said Sandra.

"I can't see what difference all this makes," said the supervisor.

"The difference," said Sandra coolly, "is that the man who ordered that meal died from a reaction to the food he ate."

The supervisor covered her mouth. "Oh my God," she said. "I—I should call my boss."

"That won't be necessary," said Sandra. "I just want to speak to that young lady over there."

"Of course. Of course." The supervisor led the way over to where Annie Delano was working. She looked to be about seventeen. She'd obviously just received a repeat order, and had done exactly what the supervisor said she would do—tap the F2 key.

"Annie," said Nadas, "this woman is a police officer. She'd like to ask you some questions."

Annie looked up, eyes wide.

"Ms. Delano," said Sandra, "last Wednesday night you processed an order from a man named Rod Churchill for a roast beef dinner."

"If you say so, ma'am," Annie said.

Sandra turned to her supervisor. "Bring it up on screen."

The supervisor leaned in and tapped out Churchill's phone number.

Annie looked at the screen, her expression blank.

"You changed his regular order," Sandra said. "He always had low-calorie gravy before, but last time you gave him regular gravy."

"I'd only have done that if that's what he asked for," said Annie.

"Do you recall him asking for a change?"

Annie looked at the screen. "I'm sorry, ma'am. I don't recall anything about that order at all. I do over two hundred orders a day, and that was over a week ago. But, honest, I wouldn't have made the change unless he asked for it."

Alexandria Philo went back to Doowap Advertising, co-opting one of the few private offices to do more interviews with Hans Larsen's coworkers. Although her particular interest was Cathy Hobson, she first briefly reinterviewed two other people so as not to make Cathy suspicious.

Once Cathy sat down, Sandra gave her a sympathetic smile. "I've just heard about your father," she said. "I'm very sorry. I lost my father last year; I know how difficult it can be."

Cathy gave a small civil nod. "Thank you."

"I'm curious, though," said Sandra, "about the fact that both Hans Larsen and your father died very close together."

Cathy sighed. "It never rains but it pours, eh?"

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Sandra nodded. "So you think it's a coincidence?"

Cathy looked shocked. "Of course it's a coincidence. I mean, goodness, I had only a peripheral involvement with Hans, and my father died of natural causes."

Sandra looked Cathy up and down, assessing her. "As far as Hans goes, we both know that what you're saying isn't true. You had some sort of romantic involvement with him." Cathy's large, blue eyes blazed defiantly. Sandra raised her hand. "Don't worry, Ms. Hobson. How you choose to run your life is your own affair—so to speak. I've no intention of exposing your infidelity to your husband—or to Hans's widow, for that matter. Assuming, that is, that you had nothing to do with his murder."

Cathy was angry. "Look—in the first place, what happened between me and Hans was a long time ago. In the second place, my husband already knows about it. I told him everything."

Sandra was surprised. "You did?"

"Yes." Cathy seemed to realize that she may have made a mistake. She pressed on. "So you see," she said, "I have nothing to hide and no reason to try to silence Hans."

"What about your father?"

Cathy looked exasperated. "Once again, he died of natural causes."

"I'm sorry to have to be the one to tell you," said Sandra, "but I'm afraid that's not true."

Cathy was angry. "Goddamn it, detective. It's hard enough going through the loss of a parent without you playing games."

Sandra nodded. "Believe me, Ms. Hobson, I would *never* say such a thing if I didn't believe it to be true. But it's a fact that your father's dinner order was tampered with."

"Dinner order? What are you talking about?"

"Your father was on a prescription drug that had severe dietary restrictions. Every Wednesday when your mother was out, he ordered dinner—always the same thing, always safe for him. But on the day he died, his dinner order was tampered with, and he received something that caused a severe reaction, forcing his blood pressure to intolerably high levels."

Cathy was flabbergasted. "What are you talking about, detective? Death by fast food?"

"I'd assumed it was an accident," said Sandra. "But I did some checking. It turns out that the national MedBase was compromised a few days before your father died. Whoever did that could have found out that he was on phenelzine."

"Phenelzine?" said Cathy. "But that's an antidepressant."

"You know it?" asked Sandra, eyebrows climbing.

"My sister was on it for a while."

"And you know about the dietary restrictions?"

"No cheese," said Cathy.

"Well, there's a lot more to it than that."

Cathy was shaking her bowed head in what looked to Sandra like very genuine astonishment. "Dad on an antidepressant," she said softly, as if talking to herself. But then she looked up and met Sandra's eyes. "This is

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crazy."

"An access log is kept for MedBase. It took a lot of work, but I checked all the accesses for the two weeks prior to your father's death. There was a bogus login three days before he died."

"Bogus, how?"

"The doctor under whose name the access was made was on vacation in Greece when it happened."

"You can log on to most databases from anywhere in the world," said Cathy.

Sandra nodded. "True. But I called Athens; the doctor swears he's been doing nothing except visiting archeological sites since he got there."

"And you can tell whose records were accessed?"

Sandra dropped her gaze for a moment. "No. Just when whoever was using the account logged on and logged off. Both accesses were at about 4:00 A.M. Toronto time—"

"That's in the middle of the day in Greece."

"Yes, but it's also when the MedBase system is under the least demand. I'm told there are almost never any access delays at that time. If someone wanted to get on and off as quickly as possible, that would be the time to do it."

"Still, using food ingredients to trigger a fatal reaction—that would require a lot of expertise."

"Indeed," said Sandra. A pause. "You have a degree in chemistry, don't you?"

Cathy exhaled noisily. "In *non-organic* chemistry, yes. I don't know anything about pharmaceuticals." She spread her hands. "This all seems pretty farfetched to me, Detective. The worst enemy my father had was the football coach from Newtonbrook Secondary School."

"And his name is?"

Cathy made an exasperated sound. "I'm joking, Detective. I don't know anyone who'd want to kill my father."

Sandra looked off in the distance. "Perhaps you're right. This job gets to you sometimes." She smiled disarmingly. "We're all a little prone to conspiracy theories, I'm afraid. Forgive me—and, please, let me say again that I'm sorry your father passed away. I *do* know what you're going through."

Cathy's voice was neutral, but her eyes were seething. "Thank you."

"Just a few more questions, then hopefully I won't have to bother you again." Sandra consulted the display on her palmtop. "Does the name Desalle mean anything to you? Jean-Louis Desalle?"

Cathy said nothing.

"He was at the University of Toronto at the same time you were there."

"That was a long time ago."

"True. Let me put it to you more directly: when I spoke to Jean-Louis Desalle, he recognized your name. Not Catherine Hobson—Catherine Churchill. And he recalled your husband, too: Peter Hobson."

"The name you mentioned," said Cathy, carefully, "is vaguely familiar."

"Have you seen Jean-Louis Desalle since university?"

"Goodness, no. I have no idea what became of him."

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Sandra nodded. "Thank you, Ms. Hobson. Thank you very much. That'll be all for now."

"Wait," said Cathy. "Why'd you ask about Jean-Louis?"

Sandra closed her palmtop and put it in her attaché case. "He's the doctor whose database account was compromised."

CHAPTER 36

Spirit, the simulation of Peter Hobson's immortal soul, continued to watch Sarkar's artificial life evolve. The process was fascinating.

Not a game.

Life.

But poor Sarkar—he lacked vision. His programs were trivial. Some simply produced cellular automata, others merely evolved shapes that resembled insects. Oh, the blue fish were impressive, but Sarkar's were nowhere near as complex as real fish, and, besides, fish hadn't been the dominant form of life on Earth for over three hundred million years.

Spirit wanted more. Much more. After all, he could now handle situations infinitely more complex than what Sarkar could deal with, and he had all the time in the Universe.

Before he began, though, he thought for a long time—thought about *exactly* what he wanted.

And then, his selection criteria defined, he set out to create it.

Peter had decided to give up on Spenser novels, at least temporarily. He'd been somewhat shamed by the fact that the Control version of himself was reading Thomas Pynchon. Scanning the living-room bookshelves, he found an old copy of *A Tale of Two Cities* his father had given him when he'd been a teenager. He'd never gotten around to reading it, but, to his embarrassment, it was the only classic he could find in the house—his days of Marlowe and Shakespeare, Descartes and Spinoza were long past. Of course he could have downloaded just about anything from the net—one nice thing about the classics: they're all public domain. But he'd been spending too much time interfacing with technology lately. An old, musty book was just the thing he needed.

Cathy was sitting on the couch, a reader in hand. Peter sat down next to her, opened his book's stiff cover, and began to read:

It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us, we were all going direct to Heaven, we were all going direct the other way.

Peter smiled to himself: a sentence worthy of the Spirit sim. Maybe being paid by the word was as good as being dead for letting one stretch out a thought.

He didn't get much farther than that before he became aware, in his peripheral vision, that Cathy had put down her reader and was staring at

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him. Peter looked at her expectantly.

"That detective Philo came to see me at work again," she said, pushing her black hair back over her ear.

Peter closed the book and put it on the end table. "I wish she'd leave you alone."

Cathy nodded. "So do I—I can't say she's a bad sort; she seems courteous enough. But she thinks there's some connection between my father's death and Hans's death."

Peter shook his head in wonder. "Your father's death was just an aneurysm or something like that."

"That's what I thought. But that detective says he may have been killed deliberately. He was on an antidepressant drug called phenelzine, and—"

"Rod? On an antidepressant?"

Cathy nodded. "I was surprised, too. The detective says he ate some food he shouldn't have and that caused his blood pressure to shoot way up. With his medical history, that was enough to kill him."

"Surely that was an accident," said Peter. "He failed to pay attention to, or maybe just misunderstood, his doctor's orders."

"My father was very meticulous, you know that. Detective Philo thinks his food order was tampered with."

Peter was incredulous. "Really?"

"That's what she says." A beat. "Do you remember Jean-Louis Desalle?"

"Jean-Louis . . . you mean Stroke?"

"Stroke?"

"That was his nickname at university. He had these veins that bulged out of his forehead. We always thought he was about to have a stroke." Peter looked out the living-room window. "Stroke Desalle. God, I haven't thought about him for years. I wonder what became of him?"

"He's a doctor, apparently. His account may have been used to access my father's medical records."

"What could Stroke possibly have against your father? I mean, heck, presumably they'd never even met."

"The detective thinks someone else was using Desalle's account."

"Oh."

"And," said Cathy, "that detective knows about me and Hans."

"You told her?"

"No, of course not. It's none of her business. But somebody did."

Peter exhaled noisily. "I knew everyone at your company must have known about it." He slapped his palm against the couch's armrest. *"Damn!"*

"Believe me," said Cathy, "I'm as embarrassed as you are."

Peter nodded. "I know. I'm sorry."

Cathy's voice was cautious, as if testing the waters. "I keep trying to think about who might have had it in for both Hans and dad."

"Any ideas?"

She looked at him for a long moment. Finally, simply, she said, "Did you do it, Peter?"

"What?"

Cathy swallowed hard. "Did you arrange for Hans and my father to be killed?"

"I don't fucking believe this," said Peter.

Cathy looked at him, saying nothing.

"How can you ask me something like that?"

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She shook her head slightly. Emotions played across her face—trepidation at having to ask the question, more fear about what the answer might be, a touch of shame over even contemplating the issue, anger simmering. "I don't know," she said, her tone not quite under control. "It's just that—well, you *do* have a motive, sort of."

"Maybe for Hans, but for your father?" Peter spread his arms. "If I killed everyone I thought was an idiot, we'd have bodies stacked up to the rafters."

Cathy said nothing.

"Besides," said Peter, feeling a need to fill the silence, "there were probably lots of angry husbands who would have liked to have seen Hans killed."

Cathy looked directly at him. "But even if what you say about other angry husbands is true, none of them would also want my father dead."

"That stupid detective is making you paranoid. I swear to you, I didn't kill your father or"—he spoke the name through clenched jaws—"Hans."

"But, if the detective is right, these were arranged deaths. . . ."

"I didn't arrange for them, either. Jesus Christ, what do you think I am?"

She shook her head. "I'm sorry. I know you wouldn't do anything like that. It's just that, well, it seems like something that someone in your position might have done . . . if that someone hadn't been you, that is."

"And I tell you—oh, Christ!"

"What?"

"Nothing."

"No, something's wrong. Tell me."

Peter was already on his feet. "Later. I've got to talk to Sarkar."

"Sarkar? You don't think he's responsible?"

"Christ, no. It's not like Hans wrote *The Satanic Verses.*"

"But—"

"I've got to go. I'll be back late." Peter grabbed his coat and headed out the front door.

Peter was driving along Post Road toward Bayview. He activated the car phone and hit the speed-dial key for Sarkar's house. His wife answered.

"Hello?"

"Hi, Raheema. It's Peter."

"Peter! How good to hear from you!"

"Thanks. Is Sarkar home?"

"He's downstairs watching the hockey game."

"Can I talk to him, please? It's very important."

"Gee," said Raheema, wistfully, "I never get to speak to him during a game. Just a sec."

At last, Sarkar's voice came on the line. "It's six-all, in sudden-death overtime, Peter. This better be *very* important."

"I'm sorry," said Peter. "But, look, did you read about that murder victim in the paper whose body was mutilated? Several weeks ago?"

"I think so, yeah."

"That was one of Cathy's coworkers."

"Oh."

"And—" said Peter, then he stopped.

"Yes?"

He's your best friend, Peter

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thought. Your best friend. He felt slightly nauseous. All those dinners together, face to face, and now he was going to have to spill it over the phone? "Cathy had an affair with him."

Sarkar sounded shocked. "Really?"

Peter forced out the word. "Yes."

"Wow," said Sarkar. "Wow."

"And you know that Cathy's father died recently."

"Of course. I was very sorry to hear that."

"I'm not sure I can say the same thing," said Peter, pausing briefly at a red light.

"What do you mean?"

"They're suggesting now that his death was murder."

"Murder!"

"Yes. Both him and Cathy's co-worker."

"A'udhu billah."

"I didn't do it," said Peter.

"Of course not."

"But I did want them dead, in a way. And—"

"You're a suspect?"

"I suppose."

"But you didn't do it?"

"No, at least not this version of me."

"This ver—oh, my goodness."

"Exactly."

"Meet me at Mirror Image," said Sarkar. He clicked off.

Peter moved into the passing lane.

Peter lived closer to Mirror Image than Sarkar himself did. Add to that Peter's head start and he ended up waiting a good thirty minutes for Sarkar, parked in a lot with only one other car in it.

Sarkar's Toyota pulled up next to Peter's Mercedes. Peter was outside his car, leaning against the passenger door.

"The Leafs won," said Sarkar. "I heard it on the way over."

An irrelevancy. Sarkar was looking for some stability in the madness. Peter nodded, accepting the comment.

"So you think . . . you think one of the sims . . . ?" Sarkar was afraid to speak the thought out loud.

Peter nodded. "Maybe." They began walking toward the glassed-in entrance to the Mirror Image offices. Sarkar pressed his thumb against the FILE scanner. "There's proof, apparently, that my father-in-law's medical records were examined, using an account that belonged to a man I knew at university."

"Oh." They were heading down a long corridor. "Still, you would need his password and such."

"At U of T, they assign account names by adding your first initial to your last name. And for passwords, the default on the first day of classes is always your own last name spelled backwards. They tell you to change it, but there's always some idiot who never does. If a simulation of me was looking for a way into the medical database, it might have tried names at random of med students I'd known back then and seen if any of them still used their old account names and passwords."

They'd come to Sarkar's computer lab. He touched his thumb against another FILE scanner. Bolts popped aside and the heavy door slid noisily

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open. "So now we must turn off the sims," said Sarkar.

Peter frowned.

"What's wrong?" said Sarkar.

"I—guess I'm just a bit reluctant to do that," Peter said. "First, of course, only one sim is likely guilty; the others don't have to suffer."

"We don't have time to play detective. We have to stop this before the guilty sim kills again."

"But will he kill again? I know why Hans was murdered, and, although I wouldn't have done the same thing, I can't honestly say I'm sorry he's dead. And I even understand why my father-in-law was killed. But there's no one else I want to see dead. Oh, there are others who have wronged me or ripped me off or made parts of my life miserable, but I honestly don't wish that any of them were dead."

Sarkar pantomimed slapping Peter's face. "Wake up, Peter. It would be criminal not to shut them off."

Peter nodded slowly. "You're right, of course. It's time to pull the plug." ■

To be concluded in the next issue.

(continued from page 71)

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THE REFERENCE LIBRARY Tom Easton

Calde of the Long Sun, Gene Wolfe, TOR, $22.95, 381 pp. (ISBN: 0-312-85583-4).
Happy Policeman, Patricia Anthony, Harcourt Brace, $21.95, 283 pp. (ISBN: 0-15-138478-9).
This Side of Judgment, J. R. Dunn, Harcourt Brace, $21.95, 291 pp. (ISBN: 0-15-100076-X).
Interface, Stephen Bury, Bantam, $11.95, 583 pp. (ISBN: 0-553-37230-0).
The Godmother, Elizabeth Ann Scarborough, Ace, $19.95, 294 pp. (ISBN: 0-441-00096-7).
Peace on Earth, Stanislaw Lem, translated by Elinor Ford with Michael Kandel, Harcourt Brace & Co., $19.95, 191 pp. (ISBN: 0-15-171554-8).

Gene Wolfe's "Long Sun" series continues strong with its third volume, **Calde of the Long Sun,** even though this book struck me as little less impressive than the first two. Wolfe's style is as grand as ever, as is his command of plot and character, but this book felt much more like a "middle" book, existing only as a part of the whole and relatively inaccessible or meaningless on its own.

So? It is part of a series, after all, and the series is a wonderful thing, set on the "whorl," the inner surface of a vast, cylindrical spaceship illuminated by a central "long sun." The protagonist is Patera Silk, an augur or priest who presides over a manteion (school and temple) in the city of Viron; his gods reside in a heaven called Mainframe and occasionally appear in Sacred Windows that are clearly computer monitors. In the first volume, *Nightside the Long Sun*, a racketeer named Blood bought the manteion. In an effort to get the manteion back, impelled by a vision of a non-Mainframe god known as the Outsider (our familiar Allah or Yahweh), Silk embarked upon a life of crime that promptly enmeshed him in his drought-stricken city's politics.

In *Lake of the Long Sun*, Silk learned a great deal about the nature, origins, age, and deterioration of his world and its gods and wound up surrounded by thieves, whores, and ordinary people who crave an end to the tyranny of the Ayuntamiento (the governing council) and the restoration of the titular head of govern-

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ment, the calde. Very much to Silk's surprise, they are even proclaiming him as the new calde, and the Ayuntamiento's troops are after him.

Calde of the Long Sun begins with the high priesthood's decision to approve Silk's promotion to calde. It then leaps to a trio of Silk's erstwhile companions, the thief Auk, the smarmy augur Incus, and the goddess-possessed prostitute Chenille, to reveal a war among the gods themselves. Meanwhile, back at the manteion, Silk's android nuns are sacrificing to the gods when the Sacred Window comes to life and heaven commands rebellion, war, insurrection.

Only then does Silk reenter the picture. He is still the embodiment of innocent, intelligent virtue, somewhat confused by all the fuss but nevertheless more than willing to grasp the nettle and do all he can to restore peace and prosperity to the whorl. His life is, of course, complicated by his wounds, the strong attraction he feels to Hyacinth, the interventions of the gods, and the vast aerial warship a neighboring city has sent to intervene. There are strong hints that Silk may be related to the late calde, who died with no child of his body to replace him, and even that the late calde may not be so late after all.

What comes next? In each volume, Wolfe answers old questions (this time, for instance, why Blood bought Silk's manteion and thereby impelled Silk toward a life of crime and political prominence) and raises new ones. Here he ends with a reminder that the whorl is failing from age and that though the drought may be over, winter must lie ahead.

Precisely what that means remains to be determined.

Attitude is everything. Or so Patricia Anthony seems to be telling us in her latest novel, the very strange and ironically titled **Happy Policeman.**

The scene is Coomey, Texas, which may or may not be the last surviving remnant of a world that perished in nuclear fire. No one really knows anything beyond the fact that one day there was a mysterious wall around the town (it's paisley today), and the alien Torku were busily supplying groceries, fuel, VCRs, and all the rest of the essentials of civilized life. The war is rumor, presumption; reality is isolation and the murder of Loretta Harper, the town's obese Mary Kay rep. Her two young sons are missing, too.

Who did it? Some folks like the Torku, who are destroying Loretta's house and capping her well, perhaps destroying evidence that something toxic is leaking under the wall. But then there are also the adulterous protagonist, DeWitt Dawson, chief of police; his dissatisfied wife and the effetely Learyesque Foster whom DeWitt suspects of being her lover; the assistant cop, Bo, who has a history of violence; the fundamentalist preacher, Jimmy Schoen, who suffers from messianic delusions; the pot-growing mayor, Curtis; and Loretta's estranged husband, Billy, whose bedroom contains a strange collection of other people's underwear.

A nicely varied mix of suspects, in

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other words, and DeWitt who must function as the intermediary between his townsfolk and the Torku and deal with his domestic frustrations even as he notices tire tracks near Loretta's body that look suspiciously like those of his own—and his wife's—car, is not a happy policeman. Nor does his mind grow calmer when the head Torku, Kol Seresen, tells him that if he would only decide and say that things were a different way, lo, they would be. Wishing can make it so:

"I try to make happy policemen. I don't know why you insist on making unhappy ones.... We worship universes, and universes leak. They leak thought. They leak dream. The pattern of the tree is in the leaf. All things affect the spin of the electron.... Your attitude is wrong. I tell you that somewhere a happy policeman with a happy family understands this. And somewhere that policeman explains to his friends. This is important to us."

But Seresen does not succeed in convincing DeWitt, at least not right away. The situation must deteriorate into a ludicrous courtroom scene complete with DeWitt-shattering revelations, a clumsy hanging, and a brief, abortive religious insurrection. And finally, at the murderer's funeral, the Torku are so impressed by the wishful thinking of the service that....

At this point, please let me shift into a more abstract gear. *Happy Policeman* is thoughtful, strange, witty, and more than a little arbitrary as Anthony tries to convince at least DeWitt that wishing can make it so. Her characters are delightfully quirky, and her tale is a pleasure. But the situation is so much a writer's device that I found it impossible to suspend my disbelief more than intermittently. I suspect Anthony's real theme has more to do with the effect of a *writer's* attitude on the realities she creates than with the effect of real people's attitude in the real world.

J. R. Dunn's first novel hybridizes cyberpunk and splatterpunk to gruesome effect. If you like the blood-and-guts school of action, you'll love **This Side of Judgment.**

Some years before the story, a Learyesque guru figure decided the path to enlightenment called for putting computer chips in one's head. He recruited followers, developed hardware and software, and tried the "chiphead" process out. Some of the experiments were immediate failures. Some were not, and the movement schismed into the guru's own group, aimed toward enlightenment, and another that saw in the new powers a path toward world dominion. Then South American forces attacked the U.S. In the ensuing chaos, the power-hungry chipheads tried to seize the country. They failed, but in the process they so terrified the government that COSSF, the Computer Subversion Strike Force) still remains on watch, hunting for remaining chipheads. Or at least it did before its old commander died and his aide, Cummins, took over. Now its efforts are half-hearted to say the least.

The situation is not to Ross Bohlen's liking. He is a COSSF field agent

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who has been confined to the office ever since recovering from injuries received on a past mission. He had been negotiating with a chiphead known only as Tap for the surrender of a group. Tap vanished after a Cummins-led raid ended in slaughter. Now Ross is scanning field reports that include a gruesome mutilation and feeling the prickle of intuition. Cummins is out of town; Bohlen hits the road for Ironwood, Montana.

Meanwhile, Telford, a chiphead who looks after those of his fellows who have succumbed to the brain damage induced by use of the chips in almost everyone, is also heading for Ironwood. Page, last representative of the power-cravers, idolizer of Stalin, brutal, sadistic, nasty-squared, is already there, laying traps, planning what he will do to Telford's local friends and certain others.

Dunn is saying here that new technologies are not necessarily bad. They may enable monsters such as Page, but such monsters have always been with us; what makes them possible is whatever edge of power they hold over the rest of us, and to be sure we don't miss this, Dunn does not only mention Stalin and the South American war but he also sets up for us a government agent who abuses his power in a thoroughly nasty way. New technologies also enable people like Telford, models of compassion and caring, who use their powers, new and old, to fight the Pages and are destroyed by those who cannot tell the difference.

Bohlen can tell the difference. He has a reputation for brashness, temper, and supreme effectiveness in hunting down the enemies of the state. But he is no wanton or stomp-'em-by-the-book killer. He feels the tragedy, and in the end this turns him to a very different mission.

By the time Dunn is done, Ironwood's snowy landscape looks as if someone had shoved a stick of dynamite down an ostomy hole. There's blood and guts everywhere. Some is from villains, some from cops, some from innocent bystanders. My own reaction was that it is rather much.

In the apotheosis Dunn gives Telford near the end, he goes too much over the top. Here the only image that comes to mind is a cartoon coyote charging over the edge of a cliff and madly churning his legs until he realizes he's supposed to fall. It's a rare reader who won't cry, "Waaiiit a minute!"

Stephen Bury's **Interface** has a nifty idea, and a number of charming, sympathetic characters, and is told in a witty, engaging way. Unfortunately, as sometimes happens, the whole is less than the sum of its parts.

The tale begins with Governor William Anthony Cozzano, paperworking alone in his office, watching the ineffectual President announce on TV that since we owe the national debt to ourselves, we should simply forgive it, forgive ourselves, and move onward into the new millennium with a clean slate.

Bury knows, in case the reader does not, that a large part of the nation's wealth is tied up in the national debt. Indeed, the nation's wealthy de-

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rive a good deal of their income from the interest on money they have loaned the government (as T bills, for instance). The President's announcement therefore produces some rather extensive panic, and the father and son gnomes who, hidden in a bunker out west, manage the top-secret Network's investments are immediately assigned the task of finding a way to straighten out the government and *protect our investment!*

Meanwhile, someone else entirely has developed a nifty new emotional-response analyzer and bumped into professional pollster and campaign manager Cy Ogle. Someone else is working on the problem of filling in damaged bits of brain tissue with silicon chips that can be programmed by radio.

It's an election year, too. And though Governor William Anthony Cozzano isn't in the running, he's a popular, charismatic politician, and he does have dreams. Unfortunately, he's also just had a stroke that scrambles his speech.

Fortunately, he has enough mind and speech left to reach his neurologist daughter, Mary Catherine, and the Cozzano family lawyer, Mel Meyer. Mel's a fixer supreme, and supremely loyal to boot. He gets the Governor out of the State House and into the hospital without the press noticing. And now the Governor, Mary Catherine, and Mel must stare the future in its rather glum face.

Meanwhile, the Network's agents are financing the rapid development of the emotional response analyzer and the brainchip. Tests are showing that they work. Feelers are extending toward a certain stroke-struck politician: interested in a high-tech cure, bubby?

Daughter and lawyer look into the feelers. What they find is a brand-new clinic, some science and technology that seems real and promising, if perhaps a bit rushed, and a hint that the clinic and its backers may be a bit more interested in Governor William Anthony Cozzano than is seemly.

But there are no other options, especially after the second stroke. They let the Governor receive his chip. They watch him improve rapidly, even as a write-in campaign to put him in the White House materializes. And they get a strange sense that he is not quite himself anymore.

And of course he isn't. That chip gives the Network's agents access to his mind, or perhaps even better from their point of view, to his tongue. He now says whatever pleases best the public (remember the emotional-response analyzers and the pollster), and the election is looking more and more like a sure thing.

Meanwhile, there's a gun-happy redneck who was hired to wear an emotional-response analyzer so Cy Ogle can tap the pulse of his particular part of the public (the economic roadkill segment; others include Bible-thumping porch monkeys, irrelevant mouth breathers, burger-flipping history majors, mid-American knick-knack queens, snuff-hawking basement dwellers, pretentious urban-lifestyle slaves, UFOs ate my brains, Orange County book burners, Sunbelt condo commandos, trade school

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metal heads, and so on). He too begins to sense that Governor Cozzano is being manipulated, and he resolves to do something about it.

There's also Eleanor Richmond, a down-and-out black woman who opens her mouth and with one incisive blast of truth demolishes a bigoted would-be politician, with the cameras watching yet. Soon she is aide to a prominent conservative politician with a taste for truth (perhaps a Goldwater figure), and not long after that—thanks in part to a comedy of errors that replaces Cy Ogle's representative of the yuppies with a bag lady—she becomes Cozzano's running mate.

Meanwhile, too, Mary Catherine, the neurologist daughter, is realizing that ambidextrous stroke victims have something extra going for them: Their brains can sometimes compensate for damage, without the help of any chips. And Daddy's ambidextrous. She insists on becoming the campaign physician so she can secretly encourage a natural recovery, and when a disgruntled hacker tells her how to block the control signals, she knows just what to do.

By now, you do too. This fat novel has a lot going for it, and Bury does a very nice job of keeping it moving. The chief drawback is surely that Bury takes so many shots at so many targets (think of that long list of segments of the public) that, even though the shots tend to make one smile every time, they wind up weakening the novel's focus and trivializing its thrust. The reader enjoys the reading all the way but cannot help thinking that though the plot moves like a freight train, the cars all have a suspicious resemblance to carnival bumper cars.

That is, Bury has generated a long string of clever, witty cheap shots that I think does the novel more harm than good.

Elizabeth Ann Scarborough's latest is a great deal of very pointed fun. **The Godmother** posits a Seattle where social problems have been exacerbated by budget problems, ideologue politicians who believe "family values" means sending kids back to their parents no matter what, and a couple of male officials who believe Daddy always knows best, loving relationships between father and child are quite natural, and all the annoying little laws against pederasty and torture (etc.) are a plot by man-hating feminists to interfere with the right and proper order of things. Scarborough is quick and loud in her disclaimer—the Seattle of the novel bears no resemblance to any other Seattle, living or dead—but every vicious absurdity on which she sets her sights does have a real-world counterpart somewhere; for appropriate testimony, read your daily paper.

So much for point. But fun? Well, consider Rose Samson. She's a social worker caught in the impotent middle who, visiting a friend who runs a quaint-clothes store, wishes that the city had a fairy godmother. The next time she visits, her friend has been replaced by Dame Felicity Fortune, who insists that she is *too* a godmother, though she has neither wings

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nor wand, and not a bibbity bob to her name.

Now meet Hank and Gigi, whose woodcutter father has gone to Alaska to look for work while their mother takes them to the mall to lose them. They meet a friendly gent who makes gingerbread houses for Christmas and just loves little kiddies, oh yes he does, and they can come home with him, but they should never, never, never go down cellar.

Here's Snohomish Quantrill, dressed in a red cloak, whose wicked stepmother has sent an assassin to do her in. Here's Cindy, whose wicked stepmother and stepsisters are out to rob her of every shred of her inheritance. Her horse is lame too, at least until Dame Fortune kicks in with a special horseshoe. Here's Puss, enlisted to help get a young man of no tremendous talents off the street.

And so on. The city has a thousand tales, and they're all mixed up, they are. As Dame Fortune tells Rose:

"The individual problems were no different than they'd ever been but because of the larger population, they got jumbled and doubled and tripled up until it was hard to tell whether you were supposed to change someone's dress and give them magic footwear, put them to sleep for a hundred years or turn them from a marionette into a real boy."

Can even a godmother with real, albeit limited, magical powers solve the city's problems? Not really. But she can arrange a few happy endings, push some of the worst ogres and wicked stepmothers off the edge of the dock, motivate a few self-help programs, and generally tip the situation a wee bit away from total catastrophe.

Is the situation a little hard to swallow? The problems aren't. The godmother is. But Scarborough makes her characters so real and their plights so poignant that we are with her all the way, even when the pace grows rather too rushed toward the end.

Fairy tales? Kid stuff? Not a bit of it. This is fairy tales for grown-ups, or fairy tales the way they was wrote an age and a half ago. Grim, gory, and ghastly, and the little dears would love them—if their parents would let them see the book.

Stanislaw Lem is renowned as Poland's original and seminal answer to H. G. Wells, Robert A. Heinlein, and Jules Verne. Born in 1921, he began writing SF in the early 1950s, and was at his peak through the 1960s though he continued to produce innovative work well into the 1980s. The latest novel to see English translation is **Peace on Earth** (originally copyrighted in 1987).

Lem's voice is distinctly idiosyncratic, even allowing for the differences between European and American approaches to SF. If he can be compared to anyone more familiar, it is to a combination of Ron Goulart and Norman Spinrad. He is an incisively barbed social critic with a keen sense of humor and a rather cavalier approach to technicalities.

Peace on Earth is an Ijon Tichy tale. Tichy is something of a secret agent who gets sent on impossible mis-

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sions. This time his mission is to visit the Moon, to which the world's nations had some time before relegated the arms race, in the form of computers and automated factories programmed to develop their own super-weapons. To keep anyone from visiting the Moon and bringing back the wherewithal to conquer all at home, the Moon has been tightly quarantined. However, the world is now worried that the Moon has gone rather too far and developed its own ambitions; attempts to inspect have failed; Ijon Tichy is therefore equipped and trained and sent forth. When he returns, he will report.

But—just before he leaves the Moon he encounters a remotely controlled ultrasonic beam that severs his corpus callosum, meaning that the two sides of his brain can no longer talk to each other. Worse yet, the two sides of his brain soon display distinct personalities. One can talk and type; the other yanks pages out of the typewriter, pinches girlish bottoms, and is otherwise a nuisance. It may have crucial memories of the lunar experience, but since it can't talk, those memories are not available.

The novel relates the events before, during, and after the Moon trip and has some interesting things to say about conflict on both Earth and Moon, as well as within Tichy's head. There are numerous witticisms, such as the name for the branch of mathematical game theory that deals with conflicts that end fatally for all parties involved: sadistics. There is a swirl of plots about Tichy as various agencies attempt to get their hands on him, hoping to interrogate his silent self and thereby gain an upper hand on Earth. There is disaster when it emerges that Tichy brought back with him a pocketful of strange dust. There is a hint that the resolution lies in a kind of disarmament and acceptance.

And there are a number of aggravations for anyone who thinks SF, even satirical, witty SF, has a responsibility to reality that is violated by mentioning ultrasound in an airless environment, robot soldiers parachuting out of an airless sky, a Moon only 200,000 miles from Earth, and stationary orbits around the Moon (a geostationary orbit is one whose period is the same as the length of Earth's day, 24 hours; a "selenostationary" orbit would have a period of four weeks and would have to be a *long* way from the Moon), among other things.

Lem is more famous than Goulart, who has the same problem, because he is considerably more thoughtful and insightful in his satire. ■

Many beautiful things have been said about money.

—Will Cuppy

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BRASS TACKS

Dear Stan:

In some pre-literate societies the Name is the Thing. In their myths to name a thing is to create it. To speak a name is to summon the thing named ("speak of the Devil") and to change something you must change its name. In general we see this as rank superstition.

It's rather disconcerting, then, to find a substantial group firmly and humorlessly practicing name magic.

The instant case is a letter in the February *Analog* in which the writer takes someone to task for attacking the politically correct (hereafter "PoCo," the first half of "poco loco") for their focus on language.

"How," the writer asks, "do you define racists or sexists if not by their speech?"

Well, how about by their actions? Or if that's too restrictive, how about their intent? Or how about the effect on the putative victims? Those are the standards we normally use to judge the rightness or wrongness of something.

"Do not underestimate the profound influence of words in creating and maintaining cultural attitudes," the author says reinforcing the point.

So, words are of themselves evil and using certain words proves you are racist and sexist because by using those words you create and maintain bigotry in our society.

And herein we have the name magic. The Words are the Things. Control the use of the words and you diminish the things. To change a thing, change the word. Calling me "organizationally challenged" is better than calling me a "slob."

What we really have here is Sapir-Worf on drugs meets the mutant spawn of Marxism in the funhouse mirror. The premises are bizarre parodies of more-or-less respectable (but not necessarily true) speculations and the conclusions wander off into semantic voodoo.

First, of course, is the elementary fallacy in logic. "If some people who use these words are sexist/racist/commie/pinkos, and this person uses these words then he/she is a sexist/racist/commie/pinko—or at best a fellow traveler."

Second is a whole mare's nest of general semantic flaws, starting with confusing the map with the territory. Note further that the argument is not phrased in terms of actions but categorical absolutes. These are not racist or sexist actions, but the work of racists and sexists. The identification is total in the PoCo mind.

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Third is a complete and total lack of proportion. Thus a reviewer who examines this confusion in a feminist's thinking by stating "suppose I were to rape X" is accused—in utter seriousness—of having, in effect, raped X. The reviewer's supposition may have been tasteless but most non-PoCos draw at least some distinction between tastelessness and physical assault.

If you notice a certain disinclination to serious analysis or even to study actual attitudes and beliefs here, you have grasped a critical point. Political correctness is the left-wing version of McCarthyism (Senator Tailgunner Joe, not Senator Clean Gene). Both attempt to deal with complex, often ambiguous and very real problems without thinking about them. PoCo-ness even goes McCarthy and his hysterical ilk one stop better by inventing "speakcrime" to supplement "thoughtcrime." To get in the red-baiter's black book you at least had to be (presumably) guilty of holding commie-symp thoughts. To get in the PoCo's black book all you have to do is use the wrong words.

Now no one but an insensitive moron would claim that jokes and off-the-cuff references cannot be acts of bigotry. Some of the cruelest acts in our society are passed off as "just a joke." The jokes you tell can be an important clue to your character.

But we also know that humor is anarchic. From the sick jokes of the '50s to Beavis and Butthead today, we laugh at what we find funny whether we "should" or not. Nor do we necessarily approve of what we laugh at, just as the people who told sick jokes would have been nauseated and horrified at a real dead baby or a rundown nun.

But what of the other PoCo tenet, that using these words creates and reinforces the attitudes?

Certainly our language reflects our world view. But PoCo-ness takes that truism and mashes it through a twin sieve of determinism and reductionism until what is left has as much resemblance to the reality as Gerber Strained Beef has to grilled sirloin. Because this thing is true in some cases, it is true in all cases. Because, therefore, this thing is one cause of the problem, it becomes the sole cause.

From this it follows logically in the PoCo mind that to attack racism and sexism we must attack the language of racism and sexism. In fact it rises to the level of positive social duty for many of the PoCo persuasion. They cannot allow any such comment to pass in their hearing without jumping on it because in their universe it means giving assent to sexism and racism.

This argument commits another, more serious, logical fallacy by confusing consequent and antecedent. If our language sometimes shapes our world view it is very much more true that our world view shapes our language. We speak of things in a particular way because that is the way we see them. Thus words take on different connotations over the years. As attitudes change even terms of opprobium become either neutral or terms of praise. Twenty-five years ago

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calling a long-hair a "freak" was an insult. Today it's simply been the term that aging hippies use to refer to themselves.

For an opposite example consider the terms which have been developed over the years as labels for mentally retarded and the handicapped. Changing the names hasn't ended the teasing that children with these conditions endure, it has simply added new words of abuse to the grade school vocabulary. The truly pernicious thing about this sort of backwards thinking is that it distracts us from dealing with the reality. Rather than dealing with discrimination, hatred, and attitudes that limit our potential, the PoCo folk waste their time worrying about the words we use.

The other problem with PoCo-ness is that—like McCarthyism—it provides a convenient rock for social cockroaches to hide under. If you were a genuine Stalinist in the '50s and '60s you could garner a fair amount of sympathy and a good deal of uncritical support by claiming to be the victim of a McCarthyist smear. Likewise the real bigots among us can claim that any expression of disapproval is an example of "political correctness" and like the Stalinist under McCarthy, get some sympathy from people who are fed up with the entire business.

Now you can argue that, like the McCarthyites, the PoCo are simply exercising their constitutional right to make grand braying asses of themselves. You would be right. But they are also stifling free speech in others and taking public debate to stupefying new lows of illogic and irrationality.

I will not take the PoCo position of demanding that this particular pack of loons be silenced for the good of the body politic, but I will suggest that people like the letter writer should not be surprised if their effusions are met with less than serious consideration.

RICK COOK

Dear Stanley,

I am writing with respect to "In the Dazzle" in *Analog*'s June 1994 issue. In this story about the adventures near a black hole, there is the standard scene of an object suspended on the edge of the event horizon, its image stuck there like a fly on flypaper. I have news for you. That scene is totally and absolutely *wrong!*

The problem comes from black holes being viewed as if they existed in Euclidean space, when in fact they are the most extreme example of the non-Euclidean nature of Einstein's Universe. A black hole can be treated as if the singularity at its center is say 5 A.U. from you. But that is based on the circumference of your orbit being 31.4 A.U. long. In fact, the event horizon itself is infinitely far away from you. Doubt me? Then look again at the object whose image is still visible a week after it entered the black hole. How far is that object from you? Somewhat less then 5 A.U.? If so, *then how fast is the light traveling?* Can light travel at only .7 A.U. per week? If so, then what happened to the speed of light being a constant, and light being able to cover an A.U. in

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about 8 minutes in this neck of the woods?

The answer to those questions is easy. If it has taken a beam of light a week to reach you, that is because it originated a light-week away from you. No other answer conforms to the constraints of relativity. Therefore, after a week, the object is almost a light-week away.

So what will actually be seen of a probe which has passed through the event horizon? It will not appear to slow down and practically stop. That effect applies only to its clocks. The probe itself will appear to accelerate away from you. Its image will red-shift as if it is being accelerated to the brink of light speed and shrink as if it is moving away at the red-shift speed. If you had a powerful enough instrument and looked from directly above its entry point, you could still find your probe a year later looking as if it is almost a light-year away, and moving away at practically light-speed. Indeed, it would still be there a million years later looking as if it's a million light-years away; and that will be because the light itself is coming from a million light-years away.

So continue in your lazy 31.4 A.U. circumference orbit. Euclidean geometry may tell you that the center of the object that you are circling is only 5 A.U. away. But in fact its edge is farther away than even the most distant quasar.

EDWARD M. SCHAEFER
Annandale, VA

Dear Stan,

I enjoyed Robert R. Chase's story, "In the Dazzle," and I'm glad to see a story which explores some of the fascinating physics of black holes. It is quite true that at the distance of 1.5 times the Schwartzschild radius, light itself orbits a black hole. But despite the fact that ambient starlight entering such an orbit could be "trapped" in orbit, even for (as Chase states) "millions of years," there's no increase in the brightness of starlight. In fact, a theorem of optics (the "brightness theorem") proves that the average brightness of a random source (such as starlight) cannot be increased, even by gravitational lensing.

It's easy enough to show. Consider a light path which exactly orbits the black hole. If you follow this light path backwards, you see that while no light exits, no light ever enters, either. Starlight can only get into the path if it's scattered into the orbital direction, for example by a small piece of cosmic dust. If light is scattered *into* the orbital sphere, however, exactly the same mechanism scatters light *out* of the sphere. If the brightness were higher in the orbit than outside, then more light would leave than enter, until the brightness inside and outside is exactly equal. The same principle holds for *every* mechanism by which light can enter a particular path. In the general case, if you follow a light path backwards to an origin far from the black hole, there is a random probability that the path points from a star, or that it points from empty space. This probability depends only on the starlight brightness outside the black hole, independent of your position.

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(Starlight is, of course, intensified by the gravitational blueshift; but there is nothing special about the radius of 1.5).

Oddly enough, the cover artist, showing the spaceship with a brilliant plasma exhaust, got it right. Light which originates *at* the light orbital radius can be trapped (at least that fraction with a path exactly perpendicular to the radius vector). Perhaps this is the true solution to the puzzle: the probes are incinerated by the glow of their own exhausts.

GEOFFREY A. LANDIS

The author replies....

My dear Dr. Schmidt:

If Mr. Schaefer is not content with the veracity of myself and my colleagues, that is no reason for him to suppose that the idea of an image suspended above a black hole's event horizon came from works of fiction. I recommend to him Harry L. Shipman's *Black Holes, Quasars, and the Universe*, particularly pages 70-75 where the phenomenon is discussed at some length. His problems with the constancy of the speed of light may be ameliorated if he conceives of light, not as Newtonian ping pong balls, but as coil springs. The front of the spring travels forward at a constant speed, but as gravitation increases the redshift, the wavelength is s-t-r-e-t-c-h-e-d. This stretching approaches an infinite length as point of emission of the photon approaches the event horizon.

I must confess that I am puzzled by the rest of his letter. My subroutines indicate that this may be an example of what humans call "humor," a concept I find exceedingly difficult to comprehend. Therefore, I must plod on assuming that his statements are to be taken literally.

How far away is an object a week after it has entered a black hole? Not a light week away at all, for it has been squeezed down to a Euclidean point at the Singularity. If Mr. Schaefer were correct and the image did not slow down, one would simply see the object disappear as it fell through the event horizon. No matter how powerful the instrument, a week later one would see nothing. The main point about a black hole, after all, is that nothing escapes. (Well, there is Hawking "evaporation," but that's another story.)

As for the brightness of the Dazzle... one must be rash to cross swords with the redoubtable Geoffery Landis, especially when he has been so gracious as to propose an alternative basis for the observed effect. However, I fear he misapprehends the situation, as evidenced by his statement that starlight can enter the Dazzle only by being "scattered into the orbital direction" as well as his assumption that following the path of light backwards proves his point. Dear me, no! Again, the point is that past certain boundaries in the vicinity of black holes, actions become irreversible.

Consider three parallel beams of light. One, passing by at a distance of 1.6 Schwartzchilds is bent, but continues on its way into space. Another, coming closest at 1.4 Schwartzchilds, is bent so severely that it eventually

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spirals down into the event horizon. The third, making its closest approach at *exactly* 1.5 Schwartzchilds goes into orbit and remains there until scattered out or until the radius of the black hole changes through accretion or evaporation, and they are either liberated or pulled down. On this basis, one might even term the Dazzle a secondary or "weak" event horizon!

Should Mr. Landis be dissatisfied with this explanation, Mr. Chase invites him, should he be in the mid-Atlantic region, to continue this discussion, perhaps with the intermediation of Mr. Jack Daniels, at a time when all three may plumb these subjects to the depths they deserve.

I trust that this elucidates matters. Ever delighted to raise the lamp of learning among the unenlightened, I beg to remain,

Your obedient servant,

DR. GIDEON FELL, A.I.

ROBERT R. CHASE

Dear Stan,

You have a good point in your June 1994 editorial. As for your question about which era of a building's life is the "authentic" one, it would seem to depend on the nature of the building. There are a lot of "birthplace" buildings in this country. Juanita and I are considering a visit to the birthplace of Carl Sandburg while traveling to a science fiction convention this summer. In this case, it seems obvious that the building should appear as it looked at the time of the birth which it celebrates, whether or not it had been changed from its appearance when built before the birth occurred or was changed later. Its importance rests on one event at one specific time. For a public building still in use, "authenticity" seems less obvious. Some changes are mandatory; it seems unlikely that Grand Central was wheelchair accessible when it was built, but it should be now. Whether other changes are for good or evil will depend quite a bit on the age of the person making the decision. Nearly everyone mourns the loss of the landscapes of youth. (I don't; mine are still there if I want to go look at them, which I mostly don't. Growing up in a small rural community has its advantages.) Possibly any changes, of "restoration" or "improvement," should be subject to public vote, with the great indifferent majority shown by their non-voting.

Michael F. Flynn's "Pson of Psychohistory" revived old memories; I hadn't thought of the Dewey & Dakin chart since Heinlein's 1952 story, "Year of the Jackpot," which was based on it. Flynn rather slides over that year; according to the chart, 1952 should have been worse than 1932, but it wasn't. There was an "Eisenhower Recession" later, but nothing to compare with the "Great Depression." Heinlein exaggerated for effect, of course, but 1952 should have been a horrendous time according to the chart. I'm afraid I don't even recall the 1988 article that Flynn refers to; I could go look it up, but that would be cheating; obviously Heinlein made more impression. I can't recall anything particularly bad about 1952, either, but then that was

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a year when I was dipping a toe into science fiction fandom and went to my first convention, the Worldcon in Chicago, where I got hooked. (I'd been reading science fiction for about five years at that point, but had never met anyone in the field.) So my personal memories of the year are good; I not only discovered science fiction fandom but I bought my first new car that year. (After two more new cars I got married and went back to driving used ones, so 1952 was a sort of financial high point.)

ROBERT "BUCK" COULSON

Dear Stan,

I'd like to make a couple of disagreements with Michael Flynn's forecast of future presidential politics. A downturn in the economy doesn't guarantee that an incumbent president will lose an election. There was an economic downturn before the 1936 election, a sort of follow-on to the Crash of 1929, and President Roosevelt survived that despite vigorous Republican efforts to blame it on the New Deal. Roosevelt had two keys to survival: one was that enough voters still blamed the Great Depression on President Hoover (unfairly) and blamed Hoover for not doing enough to alleviate the suffering, while the second was that Roosevelt was seen as doing his best to improve the situation—and succeeding, more often than not.

Assuming that there is an economic downturn according to Flynn's schedule, Clinton could still find a winning strategy for 1996. First, he can't deny the existence of the problem; instead, he must acknowledge that things are bad, and simultaneously do something to ease the situation (rather than make unfulfilled promises about great plans). This must be something effective, of course, and it will have to be done over Republican opposition (they'll have to oppose him, of course—you can't allow the other party's president to accomplish anything). Probably it would be a large-scale jobs program for the unemployed, either rammed through Congress or created and funded by executive order.

Second, he must find a way to put the blame on the Republicans—talk about the way the Reagan Deficit had crippled the economy, and point out how Republican opposition has hampered his efforts to improve the situation. Before he makes any complaints, however, he must have some solid triumphs to point out ("See, I did this despite the self-serving opposition") or he will sound like Carter: whining and ineffective. This probably sounds like a cynical analysis of the situation, but it does have a bright side. To work, it would require Clinton to be a great president, and nobody in his right mind can object to that.

Flynn talks about the "temptation, a la FDR, to get out of the depression via a foreign war." Maybe I'm reading too much into that statement, but I've heard too many slanders on Roosevelt's motives to let this pass without comment. Roosevelt did not get America into World War II. The Japanese did that. The Nazis declared war on us before we declared war on them. While we were involved in the

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war before Pearl Harbor (Lend Lease, convoy operations), there is a considerable difference between what we did while preparing to meet Axis aggression and what Roosevelt is alleged to have done to drag us into war. In addition, the war itself did not get us out of the Depression; the economy was already reviving by 1939. It was this revival (along with the Roosevelt administration's careful handling of wartime finances) which made it possible for us to afford to fight the war on the enormous scale which occurred.

Incidentally, I'd like to dispute the implication that wars are good for an incumbent president's career. The Iraq War didn't help Bush; Reagan's underhanded involvement in Nicaragua did him no good; Viet Nam didn't do any good for Johnson or Nixon; Lincoln almost lost in 1864; the Indian Wars had no real effect on nineteenth century elections; Wilson in 1916 and Roosevelt in 1940 made campaign promises to keep us out of the war; opposition to the Mexican-American War made Polk decide not to run for re-election in 1848. The Spanish-American War may have helped McKinley in 1900, but he tried to keep us out of that war—and the economy was booming. Aside from Seward's attempt to get Lincoln to declare war on Spain in 1861, I can't find any evidence that any responsible member of any administration has tried to drag this country into a war to distract the voters from domestic troubles. Considering the historical record, it looks like the worst thing a president can do to himself is to take this country into an unnecessary war.

I'm sorry to rattle on about what may seem like minor points, but I feel as keenly about historical accuracy as I do about scientific accuracy.

W. R. THOMPSON ■

He that judges without informing himself to the utmost that he is capable, cannot acquit himself of judging amiss.

—John Locke

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UPCOMING EVENTS Anthony Lewis

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BOSKONE XXXII (New England SF conference) at Sheraton Tara, Framingham, Mass. Guest of Honor—Diana Wynne Jones; Official Artist—Ruth Sanderson; Special Guest—Fred Lerner; Featured Filker—Talis Kimberley. Registration—$32 until 15 January. Info: Boskone 32, Post Office Box 809, Framingham MA 01701-0203. g.dennett@genie.geis.com

2-5 March
WORLD HORROR CONVENTION 5 at Sheraton Colony Square, Atlanta, Ga. Guests of Honor—John Farris, R.L. Stine, Neil Gaiman, Alan M. Clark, Alice Cooper. Registration—$75. Info: World Horror '95, Box 148, Clarkston GA 30021-7148 (include SASE). ekramer5@genie.geis.com

3-5 March
ASTRONOMICON 4 (Rochester area SF conference) at Radisson Inn Rochester Plaza, Rochester N.Y. Guest of Honor—David Drake; Artist Guest of Honor—Robin Wood; Fan Guests of Honor—Lloyd & Yvonne Penney. Registration—$30. Info: The Rochester Fantasy Fans, PO Box 1701, Rochester NY 14603-1701. (716) 342-4697. ralston@aol.com OR dmk@mit.edu OR stephen.rea@p10.f228.n2613.zl.fidonet.org

24-28 August
INTERSECTION (52rd World Science Fiction Convention) at Scottish Exhibition & Conference Centre, Glasgow, Scotland. Guests of Honour—Samuel R. Delany & Gerry Anderson; Fan Guest of Honour—Vin¢ Clarke; TMs—Peter Morwood & Diane Duane. Registration—£60/US$95/CDN$120/DM160/DFl180 until 30 September 1994, Supporting—£15/US$25/CDN$30/DM40/DFl45 through 1995. At-door rates not set as of the time of this listing but will be greater than current attending rates. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Join now and get to nominate and vote for the Hugo Awards and the John W. Campbell Award for Best New Writer. Info: Intersection, AdMail 336, Glasgow G2 1BR, UK or intersection@smof.demon.co.uk; Intersection, Box 15430, Washington DC 20003-4030, USA. (301) 345-5186 voice/fax.

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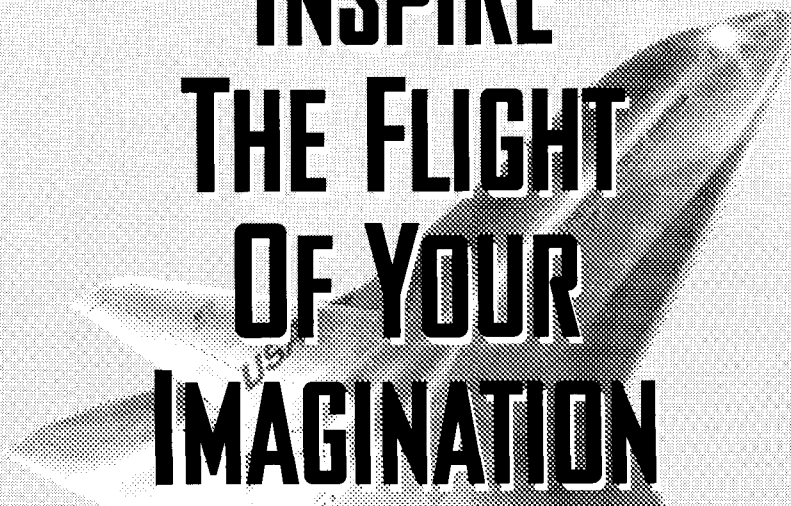

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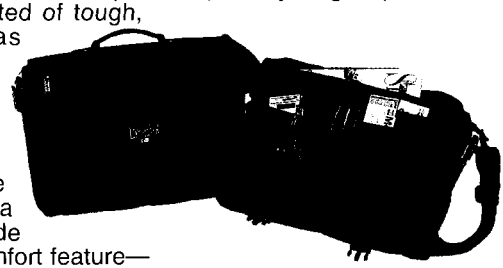

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